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AND PATTERN MAKER.

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OWING TO THE REDUCTIONS IMPOSED BY THE GOVERNMENT ON PAPER SUPPLIES, THE PROPRIETORS ARE COMPELLED TO PUBLISH "THE FOUNDRY TRADE JOURNAL" ON A THIN PAPER DURING THE CONTINUANCE OF THE RESTRICTIONS.

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—

General Secretary: E. A. Pilkington, 1, Clarence Villa, St. Catherines, Lincoln.
Manchester: J. Hogg, James Street, Radcliffe, Manchester.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Sheffield and District: J. Dickinson, 157, Abbeyfield Road, Pitsmoor, Sheffield.
Scottish: J. Macfarlane, 3, Sharrocks Street, Ibrox, Glasgow.
London: Alexander Hayes, 116, Rusthall Avenue, Bedford Park, W.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.

Contents.

	PAGE
Notes and Comments	349
Juvenile Education and Employment	350
The British Foundrymen's Association	351
Sands, Cores and Drying	357
Industrial Research in the United States	358
The Manufacture of Manganese Steel Castings	359
Electric Smelting	360
The Seasoning of Castings	361
Book Review	363
The Pattern and Mould for a Slide Valve	364
Influence and Efficiency	366
Electric Furnaces in United States Steel Foundries	367
High Air Pressures in Bessemer Converters	369
A New Design of Gas-Fired Crucible Furnace	370
Pulverised Coal as Fuel for Open-Hearth Furnaces	372
Illumination as a Factor in Manufacturing Costs	373
Non-Ferrous Notes	374
Tungsten	375
Brass-Foundry Notes	376
Correspondence	377
Queries	377
Properties of the Refractory Materials Used in the Iron and Steel Industry	378
The National Physical Laboratory	381
Trade Talk	382
Control of Timber Supplies	383
Deaths	383
Legal	384
Wood Working Machinery	384
Personal	386
Applications for Patents	386
New Companies	388
Steam-Driven Lorries and Tractors	388
Profits on Sub-Contracts	388
Monthly Price List	390

NOTES AND COMMENTS.

British Foundrymen's Association.

Meetings of technical societies do not excite quite so much interest at present as in normal times, and even were this not the case, existing conditions demand too much attention to permit a tangible expression of interest on the part of many. Nevertheless, the Annual Meeting of the British Foundrymen was fairly well attended, particularly in view of the absence of the customary presentation of papers and lectures, and the social functions which in the past have done so much to bring members together. While few would approve of resuming the latter during the war, it is the opinion of many that an effort should have been made to resume the technical and educational activities. There are members and friends of the Association who still find time to continue this work at the Branch meetings, even though deeply involved in war work; and to include a selection of papers in the programme of the annual meeting would only mean an extension of Branch activities.

That the progress of the Association continues despite the restrictions imposed by war is evident from the fact that the past twelve months has witnessed an increase of fifty-six in the membership; though in view of the great increase in foundry and metallurgical activity this increase is not as great as might be wished. Doubtless we shall see a marked increase in membership and activity alike when individual members have more time at liberty to devote to the interests of the Association; for essentially the progress of such an institution is dependent on the individual efforts of the members generally, however much the energy and personality of the officers may do.

Training of Boys.

In the course of his Presidential Address Mr. Ellis dwelt rather strongly on the boy labour problem and the questions with which the Association will have to deal very soon. His remarks were emphasised by other speakers, and while little unanimity of opinion was expressed as to methods and details, the generally expressed opinion was in agreement on the necessity of tackling the problem on bold lines. Too much stress cannot be laid on the words of the President, who said:—"It is all too easy to forget that the boy of to-day is the man of to-morrow; and that the future of the trade is dependent on these same boys whom we too often regard as mere sources of income to the foundry proprietor. . . . The penalty which the foundry trade will have to pay for any abuse of its young labour supply is dire shortage of that supply, if not worse."

In this we have the crux of the whole matter. It is not a question of whether some individual finds it a matter of inconvenience to treat boy labour on the right lines; it is rather a question of whether the trade shall permit a system to per-

sist which is steadily denuding it of its future skilled craftsmen. When that question arises personal and individual considerations must be withdrawn, though national action alone can do that effectively.

Attention might also be drawn to the remarks by Mr. T. H. Firth respecting labour generally. He said he was a believer in big wages. A poor man was no good. Labour must do its best and employers must pay them well. The Government should see that every man had continuity of employment with a guaranteed minimum wage, so that he could afford to keep his wife and family respectably. Britain could hold her own if capital and labour worked together, because there was plenty of work if it were only properly distributed.

It is not within our general province, nor that of the Association, to discuss questions of labour and wages; but when the subjects of works efficiency, technical progress, and the maintenance of craftsmanship arise, it is found that the connection between wages, conditions of work and efficiency is so intimate that neither can be discussed properly if detached. More than normal tact will be required by the Association in dealing with the problems before them, if they are to avoid becoming involved in disputations on labour and wages.

The Need for Research.

The annual recurrence of the report of the National Physical Laboratory again reminds us of the importance of such institutions in relation to industrial progress. If any in the past have doubted the value of the Laboratory their doubts should have been finally dispelled by the admirable service it has rendered during the war; and when it is remembered that similar service has continually been rendered by it, though not under conditions to bring it into such prominent public notice, the case for its proper support by the Government is seen to be established.

A glance round the field of metallurgy alone, apart from general enginering, reveals a host of subjects wrapped in obscurity—processes being conducted in almost blindfold fashion, based on limited and not understood experience, and methods and practice varying so widely as to inevitably involve industrial waste. Research on refined lines is extremely difficult in the course of industrial operations, and for small competitive concerns it is impossible; but co-operation with such research institutions as the National Physical Laboratory is possible for all who are engaged in industry. It is this co-operation and support on which our national existence will depend in the future, and the sooner each trade co-ordinates its ideas and establishes such a movement the better for the trades. The foundry world is lacking neither in problems nor the brains and facilities for dealing with them; and given a strong authoritative lead support for any movement to advancement should not be wanting.

Juvenile Education and Employment.

Summaries of the evidence given before the Departmental Committee appointed to inquire into the subject of Juvenile Education in relation to employment after the war are contained in Vol. II. of the Final Report of the Committee recently issued. Nine classes of representative witnesses were called before the Committee, including representatives of employers and of labour, officers of Government Departments, representatives of local authorities and organisations of such authorities, officers of education authorities and representative teachers, and several leading social workers.

Sir Hugh Bell said that with regard to the school-leaving age he favoured raising it to 16, but saw great economic difficulties, and under present conditions he would not object to a leaving age of 14 without any form of exemption. If the period of change could be bridged, any inconvenience would be much more than compensated by the improved earning power of the nation. If a boy of 14 could not get occupation with suitable prospects, he should be compelled to remain at school. He considered that too early specialisation of teaching was a mistake, but towards the end of the elementary school curriculum some special science teaching of a kind likely to be useful to the pupil in after life should be given. Attempts to teach a trade should not be made in the elementary schools, and the tendency to devote time to teaching manual dexterity was to be deprecated. Giving some outline of the four years' engineering course at the Middlesbrough High School to boys of 16 by classes held during the time of the employer, he said he hoped that the system of part-time day classes might be largely extended. Without compulsion it would be impossible to get the system widespread, and he would not object strongly to compulsion, but thought it better only to send the willing boy, and have attendance regarded as a privilege. He would not approve compulsory evening classes for young people more or less exhausted by a day's work, and he regarded works' schools with disfavour, thinking it well to draw a sharp line between school and workshop.

Mr. Arthur Balfour (Sheffield) said the school-leaving age in Sheffield had lately been reduced to 13, owing to shortage of labour and the urgent necessity for the production of steel, but half-time employment had been almost entirely elminated in Sheffield, and he emphatically favoured its complete abolition. Children taking up employment on leaving school at 14 should be compelled to attend trade schools in working hours for at least two half-days a week. He saw no difficulty as an employer in arranging for this, and said relays of other boys, or, if necessary, women could be employed in place of boys attending trade schools. He was opposed to compulsory evening classes, as imposing too great a physical strain on young people.

Mr. Samuel Osborn thought it would be very difficult in the Sheffield trade to let boys off in relays to attend day classes. Nevertheless manufacturers would no doubt soon adapt themselves to the enforcement of part-time day classes. He favoured the raising of the school-leaving age to a uniform 14, and thought local authorities should be given power to raise the age to 15, which, though desirable, was hardly practicable at present. His firm had endeavoured to encourage attendance at evening continuation classes, but, in spite of the excellent facilities available in the city, their experience had not been very satisfactory.

The British Foundrymen's Association.

The Annual General Meeting of the British Foundrymen's Association, for the election of officers, was held in London on Saturday, June 23.

The PRESIDENT (Mr. J. Ellis), in extending a hearty welcome to the members, said that despite the fact that they were all so exceedingly busy and harassed in these dreadful times, yet they were able to be present in fairly large numbers. Although they had dispensed with the social functions, he sometimes thought it would perhaps have been beneficial if the Association had gone on with its educational programme at the annual meetings. However, the Council had decided otherwise, and it was not for him to go contrary to them. In consequence of a slight deafness he

MR. J. ELLIS

(President of the British Foundrymen's Association).

proposed to ask the Senior Vice-President to take the chair during the meeting.

MR. T. H. FIRTH, of Sheffield, then took the chair.

The minutes of the previous Annual General Meeting were read and confirmed, and the Chairman then referred to the Report of the Council.

Report of Council for 1916.

The General Council have pleasure in presenting to members the following report of the progress and work of the Association during the past session. Five General Council meetings have been held, three at Birmingham and two at London, and members have attended from :—Birmingham, Cardiff, Coventry, Derby, Dumbarton, Gloucester, Horsehay, Leicester, London, Luton, Manchester, Sheffield and Warrington.

Notwithstanding the many duties and distractions inseparable from the prosecution of a great war, the Branches are doing excellent and valuable work in the foundry trade. Many interesting Papers have been given and discussed, and visits to various works have been much appreciated by the members.

Five members of the General Council are retiring according to rule, and are eligible for re-election. The following have been nominated :—*J. E. H. Allbut, Manchester; W. H. Aston, London; *W. F. Bagnall, Sheffield; J. Feasey, Lincoln; J. Gaunt, London; D. Gordon, London; *H. Pemberton, Derby; *J. G. Robinson, Halifax; *T. Swinden, Sheffield.

MR. T. H. FIRTH.

(Senior Vice-President of the British Foundrymen's Association).

Funds to the value of £350 have been invested in War Loan.

The increase in numbers at the present time shows appreciable interest being taken in the Association. The respective Branches have the following members attached to them :—

	Members.	Associate Members.	Associates.	Total.
Birmingham ...	12 (12)	76 (64)	47 (47)	135
East Midlands ...	21 (18)	44 (36)	27 (16)	92
Lancashire	33 (33)	90 (91)	27 (33)	150
London	44 (40)	61 (52)	11 (13)	116
Newcastle	29 (29)	57 (46)	30 (26)	116*
Scottish	37 (36)	95 (89)	56 (52)	188
Sheffield	46 (40)	83 (83)	18 (20)	147
Unattached and Honorary	39 (30)	30 (31)	8 (23)	77
Totals ...	261	536	224	1,021

The figures shown in brackets are last year's figures.

* Retiring members.

The total number of members on the roll of the Association is 1,021, against 965 last year. Six members, 16 associate members, 38 associates, making a total of 60, have ceased to be members; 36 members, 51 associate members, 32 associates, making a total of 116, have been elected.

The Council deeply regret the death during the year of Mr. Herbert Pilkington, M.Inst.C.E., M.Inst.Mech.E., the second President of the Association. Mr. Pilkington gave most valuable assistance from the beginning of the Association, and by his organising abilities made his mark on the work and conduct of the Association. His presence and help will be missed by the General Council and members, who extend to his widow and family their heartfelt sympathy.

Many of our members are serving their country, and several have laid down their lives for the cause. For those still at the Front we wish a happy return at an early date, and to those who will never return we accord our lasting gratitude.

The accounts for the year ended December 31, 1916, are now submitted, having been duly audited.

INCOME AND EXPENDITURE ACCOUNT.

January 1 *to December* 31, 1916.

EXPENDITURE.

	£ s. d.	£ s. d.
Postages		38 14 4
Printing and Stationery (including printing of Proceedings)		132 0 0
Council, Finance and Annual Meeting Expenses		12 1 11
Branch Expenses, viz.:		
Lancashire	18 4 5	
Sheffield	16 13 9	
Scottish	22 12 4	
Newcastle	19 19 8	
Birmingham	11 6 4½	
London	22 5 7	
East Midlands	17 4 3½	
		128 5 6
Illuminated Addresses		6 19 6
Audit Fee		4 4 0
Clerical Assistance		15 0 0
Incidental Expenses		11 16 4
Honorarium to Secretary		42 0 0
		£391 2 7

INCOME.

	£ s. d.
Subscriptions received	364 15 6
Sale of Books, etc.	3 1 0
Interest on Exchequer Bonds	4 7 8
Balance—being excess of Expenditure over Income	18 18 5
	£391 2 7

BALANCE SHEET.

December 31, 1916.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance		24 15 0
Sundry Creditors		109 11 5
Surplus as at 31st December, 1915	226 3 8½	
Less Excess of Expenditure over Income for year ended 31st December, 1916	18 18 5	
		207 5 3½
		£340 11 8½

NOTE.—There are arrears of subscriptions amounting to £205 7s. 0d. which are not included in these Accounts.

ASSETS.

	£ s. d.	£ s. d.
Cash in hands of Secretaries, viz.:		
Lancashire	2 2 6	
Scottish	5 4 8	
London	11 14 11	
East Midlands	6 6 5	
General Secretary	17 7 2½	
		42 15 8½
Less Balance due to Secretary, Newcastle	0 5 11	
" " Birmingham	4 3 3½	
" " Sheffield	0 2 11½	
		4 12 2
		38 3 6½
London City & Midland Bank, Ltd.		83 14 8
Furniture, Fixtures, and Fittings		18 13 6
Investment Account—Exchequer Bonds		200 0 0
		£340 11 8½

We have examined the above Balance Sheet with the books and vouchers of the Association, and find same to be in accordance therewith.

FRANK CREES, HARCOURT & Co., *Auditors*,
23, Colemore Row, Birmingham.

1*st June*, 1917.

In presenting the Council's report for the past year, the Chairman remarked that there was not much to be said with regard to it. According to the balance-sheet there was an expenditure over income of £18 8s. 5d., but there were arrears of subscriptions amounting to £205, and most of that had since been collected. The Association had been enabled to put £350 into the War Loan. It was not a large amount, but for a young association like theirs it was a beginning in the right direction and he hoped next year they would be able to do more. He asked for any comments upon the report and balance-sheet.

MR. R. CARRICK remarked that the Halifax Branch was not mentioned in the report. Had it been disbanded?

The CHAIRMAN said the Halifax Branch had felt the stress of the war and it had been thought best to let it drop for the present. It was hoped that the Branch would be revived next year. The President had recently been in Halifax on an official visit, and he thought there was no question but that the Branch would be working again next year.

MR. CARRICK said he raised the point because he was a Vice-President of the Halifax Branch, and he did not know until he received the Council's report that it had been disbanded. He thought the members of the Halifax Branch ought to have been given some statement as to the condition of things.

The CHAIRMAN agreed that something ought to have been said about the matter in the Council's report. However, the facts were as he had stated. The Branch had a Secretary who was anxious to do something, but he was tied up. He could not get a President, and the General Secretary was looking after the position as best he could in the circumstances. It was hoped to report something very much better about the Branch next year. As a member of the Council, he apologised that something was not said about the matter in the report. As far as he was concerned, it had been overlooked. Everybody appreciated what Mr. Robinson (the Branch Secretary) had done for the Association in Halifax, and for that reason he had every confidence that the Branch would be revived later.

Election of Officers.

The CHAIRMAN, speaking on this matter, remarked that while the opinion existed that for many reasons the term of Presidency of the Asso-

ciation should be only one year, under the existing abnormal conditions the old arrangement of two years had much to recommend it. He had personally pressed Mr. Ellis very hard indeed to take up the position for another year. Mr. Ellis did not want to, but he agreed, out of good will for the Association. He had done a good deal for the Association, and had kept closely in touch with all the Branches throughout the year; and though in ordinary circumstances it was not well for one man to be President for more than one year, since the interests of the Association demanded it the President had consented to hold office for another year. When he (the speaker) took office he hoped the war would be over, for he wanted the members to come to Sheffield, so that he could show them what Sheffield could do and what Sheffield was doing and what Sheffield had done for the war.

Mr. Jones said he had very much pleasure in seconding the proposition, that Mr. Ellis be elected for another year.

The motion was put to the meeting and carried unanimously with applause.

Mr. Ellis said nothing gave him greater pleasure than to feel that the members wanted him for another year, whatever the circumstances. It was considered by his immediate predecessor that the greatest honour that could be given to a foundryman was to be elected President of the Association. That honour he felt doubly, and from his own personal point of view it had been a very great pleasure to visit the Branches. Every one of them had extended to him the warmest sympathy and friendship and good fellowship, and it was very pleasing to recall that there existed between the Branches and the parent Association a very great affection. Each of the Branches was out to exert all the energy it possibly could to further the interests of the Briish Foundrymen's Association. He assured the members that in the future, as in the past, he would strain every nerve to further the interests of the Association.

Continuing, the President said he had now, perhaps, the most pleasing duty of all, and that was to propose the election of Mr. Firth as Senior Vice-President. There was no need for him to dilate upon the qualities of Mr. Firth. They all knew him well as a thorough business man and how hard he had worked during the past year in carrying on the business of the Association.

Mr. W. H. Aston heartily endorsed the proposal. He had been in touch with Mr. Firth for some considerable time, and was certain that when he became President he would not only assist but adorn the Association.

The proposition was carried with acclamation.

Mr. Firth, in expressing his thanks, said he was only a fairly young member of the Association, but he was convinced that if the members all pulled together the Association would be of some national good. Anything he could do for the advancement of the Association he would certainly do. When the war was over he looked forward to very much larger annual meetings than were now possible.

On the proposition of Mr. W. Mayer, seconded by Mr. Pemberton, Mr. J. Little was elected Junior Vice-President.

Mr. Jones proposed, and Mr. Buchanan seconded, that Mr. Finch be reappointed treasurer. The proposition was carried.

Mr. Finch thanked the members for re-electing him. The balance in the bank was now, he said, £95 11s. 3d. Last year he had had the pleasure of placing £200 in the War Loan, and this year another £150 had been invested in the same way. The first £200 had been converted into stock free of income tax, and arrangements were being made for dealing with the £150 in the same way.

Mr. Mayer, proposing the re-election of Mr. E. A. Pilkington as general secretary, paid a tribute to his work in the past.

Mr. W. F. Bagnall seconded, and the proposition was carried.

Messrs. Frank Creke, Harcourt & Co. were reappointed auditors.

Mr. Pemberton proposed that Mr. Mayer be appointed a trustee in place of the late Mr. Pilkington and that Messrs. Cook and Buchanan be reappointed trustees.

Mr. W. F. Bagnall seconded, and the motion was carried.

Mr. Ellis then made a presentation of an illuminated address to Mr. W. Mayer. Everybody, he said, knew the great amount of work that Mr. Mayer had done for the Association when he was President; he was quite confident that he crammed as much work into his year of office as any of them could get into two or three years. Every Branch of the Association from South to North was visited by Mr. Mayer. Apart from that, Mr. Mayer's genial presence and jovial manner in dealing with things went to the heart of everybody, and they all acclaimed Mr. Mayer as an ideal President. He was sure all present would endorse that sentiment. Therefore they were anxious to show Mr. Mayer just a little of their gratitude towards him. Apart from the work he had done he merited the gratitude of the Association for the magnificent chain of office which he had presented to the Association. The little token which the Association wished to present to Mr. Mayer was offered as a slight recognition of the good work he had put into the Association and the good feeling that he had towards it.

Mr. Mayer, speaking with some emotion, expressed his thanks for the gift. The President had overrated the work he had done for the Association; what he had done he had been proud to do. There was one thing, however, he would claim, and that was he gave way to none in his wish for the continued success and progress of the foundry trade. He had been associated with the B.F.A. long enough to know the great work the Association was achieving throughout the trade, and it was, therefore, that he hoped all master founders in the country would join the Association. Many master founders were not members, but they were benefiting by the work which the Association was doing for the trade. For that reason he contended it was the duty of every master founder not only to join the Association himself, but to encourage his staff to join, even to the extent of paying their subscriptions, as he himself did. As to the address which was then being presented to him, he would be very proud of it to the end of his life.

Mr. R. Buchanan, referring to the death of the late Mr. H. Pilkington, said he thought it only right and proper and due to his memory that they should place on official record their sense of the great loss they had sustained. Mr. Pilkington was the second President of the Association, and did good work in re-organising it. Until recent years, when his health failed him, he continued to take a very close interest in the affairs of the Association. Anyone who was brought into contact with him was struck by his force of character and his organising ability. He therefore formally moved a vote

of condolence with Mrs. Pilkington and her family in their great loss.

The proposition was passed by the members rising.

The result of the ballot for members of Council was announced as follows:—Mr. J. E. H. Allbutt, 30 votes; Mr. Pemberton, 24 votes; Mr. W. H. Aston, 18 votes; Mr. Gaunt, 18 votes; Mr. Robinson, 18 votes.

Mr. Ellis then delivered his Presidential Address as follows:—

President's Address.

In the course of the Presidential address at the last annual meeting of this association I dealt in a brief way with the work the Association had accomplished since its inception. While reviews are interesting and instructive, however, it is still more useful to examine the requirements of the future and to determine the lines on which the present policy and activities of the Association should be conducted. The changes wrought by the deplorable war in which we are still engaged, and the startling readjustment of ideas caused thereby, have started a new rate of progress in foundry developments. Changes in personnel, equipment, methods, and particularly in nature of work have been established temporarily, and no one can say to what extent the future character of foundry operations will be modified thereby. Many of the innovations in question will probably prove to be only temporary, but others may offer such advantages as to justify their permanence. A too hasty reversion to old ideas and methods when the exigencies of war work relax might waste what would otherwise be an excellent opportunity for establishing progressive ideas; but at the same time one must remember that many things are permissible in war time, and under stress of urgency, that would not be countenanced under competitive industrial conditions in peace time.

Next, what will be the position of our foundries after the war, in regard to equipment and available skilled labour. Like other trades, the foundry trade has already suffered by the depletion of its skilled labour supply, and many of those who have gone have given their lives for their country, while others will not return to founding as an occupation. Further, the rush of specialised work and the extraordinary demand for boy labour in other directions has practically stopped the training of new young founders to take the place of those who fall out of the lists from time to time. To get good foundry workmen was difficult enough before the war, and to get boys willing to train for the work was more difficult, but these troubles will be intensified in the near future. What is the nation doing to deal with this problem, which occurs in other trades as well? Moreover, what is this Association doing in the matter in relation to its own trade?

It is evident that any course of action in dealing with the question, to be effective under present and near future conditions, must not rely on individual efforts. Desultory efforts at training and education may extend over years, and produce no tangible result, but if the question is treated as a national problem, and Government support secured, we may look for the foundry trade to be placed on equality with other trades in the matter of technical education and training facilities.

The foundry offers a very serious problem in the matter of young employees; and not only will methods of education call for attention, but we shall be forced to face the question of attracting lads to the trade. Much might be—and in fact has been—written about the intricacies of foundry work and the fascination of the trade with its never-ceasing list of problems. But though we as foundrymen may revel in the romance of our trade, it is difficult to inspire the soul of an outsider with the same sense of the foundry's romance. The engineering trade generally often does not even care to acknowledge that founding is a highly skilled calling, despite the fact that the demands on the foundry's resources and intelligence are yearly becoming much greater. Knowing, then, what is the attitude of the layman to our trade, we have another educational problem to face—that of educating the public to a sense of our importance and the value of our work.

When all these points have received attention, there still remains a really important consideration which we cannot afford to ignore, and that is the condition of our foundries from the health and comfort standpoint. It would be foolish to pretend that the foundry is generally a clean workshop, for it is often objectionably dirty; and often it is unnecessarily so, for want of a little thought, expenditure and clear-sightedness. Intelligent employers are at length beginning to realise that there is a definite connection between cleanliness and comfort of working conditions on the one hand, and quality of workmanship and output on the other. Unfortunately, it is not yet hard to find dark and dirty foundries, but the various well-equipped, clean establishments that are also to be found stand as proof of the value of decent working conditions, and a lesson in possibilities, despite the nature of the founder's work.

Care for the welfare of employees is always repaid in results, and even if the State does not soon insist on the regular establishment of what is now known as welfare work, on behalf particularly of the young employees, the law of expediency would insist on attention being given to it. Could this Association not give a lead to the trade in this matter by at least bringing before its members what work has been done in respect to the welfare of foundry operatives. In this, as in many other matters, we should regard the Association as the normal source of inspiration in progressive ideas. It should not be for us to lag tamely in the wake of progress set by force of circumstance. We should anticipate circumstance by exercising our combined intelligence and imagination.

In discussing these points I find myself unconsciously reverting to the boy in the trade, for it is in him that our great problem is centred. For the assistance of foundry lads it might be well to consider the possibility of forming a junior section of the Association, which could supplement the work designed for the older men by more elementary instruction suited to the needs of beginners in the trade. At present we are faced with the difficulty of catering for the mental needs of skilled and experienced craftsmen, and also those who lack knowledge of very elementary foundry matters. It is difficult to reconcile these two classes of requirements at our monthly lectures and addresses; but with separate courses designed to carry the student from the early steps of foundry knowledge upwards much good might be done.

This same consideration for the boys should extend to their operations in the foundry. The

Association should set its face firmly against the practice of keeping boys at one class of work indefinitely, and making them mere money-producers at the expense of their training. It is all too easy to forget that the boy of to-day is the man of to-morrow; and that the future of the trade is dependent on these same boys whom we too often regard as mere sources of income to the foundry proprietor. Nature has her revenge on those who transgress her laws, and that revenge is extinction if the transgressions persist. This applies equally to social and industrial laws; and the penalty which the foundry trade will have to pay for any abuse of its young labour supply is dire shortage of that supply, if not worse. We who regard our calling with respect and affection should, therefore, oppose all abuses of economic or industrial law as applied to foundry work and workers.

In little matters also it is wrong to discourage a boy. If he makes a " waster " it is probably not his fault, and if he is discouraged and disheartened by his foreman he will probably never give the trade a fair trial. A little instruction and help is worth all the discouragement in the world; for not many boys will rise superior to harsh criticism and determine to do better. Rather will the average boy seek another occupation.

Further, I consider that boys who take up the foundry trade should be encouraged to enlarge their knowledge of associated branches. They should be given three months' experience in the drawing office, three months in the pattern shop, and then go into the foundry. This would make many foundry operations so much more intelligible and interesting, in the light of a knowledge of the ultimate destiny of the casting. Young draughtsmen, too, should be given three months in the foundry, three months in the fitting-shop and three months in the pattern-making shop, while young fitters should be given similar terms in the other three departments mentioned, receiving practical lessons in each. Where a laboratory exists in the works much good would result from making the boys acquainted with the scientific aspects of their work.

Lastly, in all training it should be remembered that the development of intelligence and not scholastic attainments is necessary. The superficial capacity to display " fancy " ability is incomparably inferior to the ability to face problems intelligently and deduce cause and result. There is nothing gained by " cramming " knowledge so-called into the heads of boys unless the capacity to retain and apply that knowledge is developed.

Among other unlooked-for developments resulting from the war is the increased prominence of women workers in the foundry. For years we have been accustomed to their presence in certain branches, such as core-making; but their employment is now being extended to other departments. Undoubtedly we shall find metallurgical and chemical work a standard occupation for women in future, and it might be well to extend to the ladies a kindly welcome to the Association's membership roll—not merely as an act of gallantry, but as an invitation to respected co-workers in a dignfied calling.

In the foregoing I have touched on some of the possibilities and problems involved in the future of our trade generally and the British Foundrymen's Association in particular. I earnestly entreat all my fellow-members to exert their utmost efforts to increase the scope and influence of the Association, so that its work may have the fullest force and authority with which it is possible to endow it. There is no other Association constituted to maintain the interests of foundry education and technical progress, and on us devolves the duty of meeting the demands of the changing condition of industry. Not one or two individuals alone, but all the members, should give whatever time and attention they can spare to placing the Association on a firm footing as the truly representative foundry body. It has been suggested to me that we should make an organised effort to treat with some of the numerous standing problems of our trade, by means of technical committees, or in some such way. The suggestion is worthy of attention, for it would not only profit the members, but would show the engineering world that we are a really active body determined to stimulate and support progress in the trade of which we are justly proud.

Discussion.

Mr. T. H. Firth said that the President had certainly given them something to think about. With regard to boys, there was no question about it, something would have to be done. Unless they did something for the boys they would not get them into the foundry. So far as Sheffield was concerned, the class of boy they were getting was not such that they could take them into the drawing office. They were not getting the class of boy they ought to, and something must be done to alter that. Then the employers must have more trust from their employees. He could not understand it, but somehow or other they did not seem to work together as they ought to. Employers must do something to make the employees feel they were endeavouring to do something for them as well as expecting the employees to do something for the employers. He was a big believer in big wages. A poor man was no good. The British Foundrymen's Association went to Manchester not long ago to see the Ford works, and there they had not a labourer sweeping up the shop floor who was earning less than £3 per week, and he earned it. It was known that other men were wanting the job, and the labourers did twice as much work as the ordinary man earning the ordinary money. They did not want to grind their workpeople down; both their interests were identical. Labour must do its best and employers must pay them well. His own idea was that the Government would have to see that every man should have continuity of employment with a guaranteed minimum wage, so that he could afford to keep his wife and family respectably. They could not expect a man to do his best knowing that he could be "sacked " at any moment. There was plenty of work, and would be plenty, for every man, and when they were dealt with on the lines he had indicated there would be no need to ever fear Germany or anybody else again. Britain could hold her own if capital and labour worked together, because there was plenty of work if it were only properly distributed, and something would certainly have to be done. They must show their workpeople that they did not wish to grind them; they wanted to help them, and show that there was something more in life than merely grinding out a living. The workpeople wanted something brighter to look to. Therefore he supported everything the President had said with regard to the boys. The Association had got to do something, otherwise the industry would not have the boys, and if they did not have the boys they would not have the men. They must make the foundry more comfortable for them and

cleaner. The welfare movement was a good thing, and, in thanking the President for his address, he expressed the hope that good would come of it.

Mr. E. Gallon (Newcastle) said he had listened with very great pleasure to the Presidential address, and felt that it was necessary, for the foundry trade to develop a sense of its own importance. At the present time the foundryman was looked upon as of no importance whatever, and whose fault was that? It was his own. One of the best ways of getting the importance of their work recognised was to stand up for a fair price for the work they did for engineers. Hitherto they had not had a fair price for their product, and that was why they could not pay high wages. If they got a fair price they could pay high wages, but if they were to go on cutting each other's throats they would never improve the position of the trade as a whole. Therefore they would have to look after the boys if they wished the trade to have any importance at all in the engineering world. The class of boy that was now coming to the foundry was very difficult to deal with. Somehow or other he did not seem to have the intelligence to grasp the idea that when he was spoken to about a bad casting he was being spoken to as much for his own good as for the good of his master. Until they could devise a method of getting at the boy and impressing upon him the fact that the master was really interested in him he was convinced they would not make much headway. He (the speaker) was diametrically opposed to the policy of training which took the drawing office first, then the pattern shop and then the foundry. He would reverse the order, because in the drawing office the boy came at nine o'clock and left at five o'clock. When he came to the pattern shop he had to start at six o'clock, and his back was up at once. He had been spoiled by starting in the drawing office. If the process were reversed, by the time the boy reached the drawing office he would have learned to know a little about mechanics, and would understand the drawings much better than if he started in the drawing office first, because he would probably lose in the foundry what he had learned in the drawing office.

Mr. H. L. Reason (Birmingham) said that one of the chief points that struck him was the reference to boy labour. They all knew that at present boy labour was being absorbed by machine shops at very high wages, and in this way it was being taken taken away from the foundries. We must not lose sight of the fact that we are living in abnormal times, and that the great scarcity of boy labour would to some extent be modified after the war. With regard to female labour, most of those present were no doubt quite aware, and, like himself, had been astonished, at the wonders that had been achieved by female labour. If it could be used in the proper way—he did not mean for men's work, but in much work in the foundry that could could be done equally well by women as by men, such as small core and repetition work—things that could be done quite as expeditiously and well by female as male labour, and so take advantage of the large amount of female labour available—the foundry trade would place itself in a good position to meet the terrible competition that was bound to take place after the war. He thought it was time the British Foundrymen's Association rose to the occasion and did something of national importance that would bring them before the world to show the world that they stood for the trade and could tell the trade what it was necessary to know.

Mr. Carrick said he had raised that same question three or four years ago, that some kind of committee ought to be formed to deal with technical matters and lay expert information at any rate before their own members and before the country. The matter was then shelved, but he thought the time was now opportune to appoint a committee to centralise problems of this sort. The best information could be obtained by the committee, and it could be issued to the members in circular form.

Mr. Frith said the Council would deal with the matter at their next meeting.

Mr. H. G. Barrett suggested that the Council should get out a circular to the whole of the engineering trade showing the employers of labour what the British Foundrymen's Association was doing. This ought to get men into the movement who were interested. In the past when a workman had attempted to advance himself, and it has been discovered that he had been in a foundry, it had generally been a bar, and that, he thought, was through lack of knowledge of what the founder was.

Lieut. Alex. Hayes raised a point with regard to the system of electing the Council. The annual meeting elected Councilmen for two years and the Branches elected Councilmen for one year, and there was the anomalous position that whilst a member had been elected by a Branch and was serving he was also elected by the annual meeting. Was it not possible to obviate this, as both sets of Councilmen were on the same footing? If necessary the Branch should elect them for two years. Also Branch Secretaries were entitled to attend the Council meetings, but very little of a definite nature was said as to their voting authority until in a recently issued circular they were stated to have no voting power. Were they merely to hold a watching brief? He suggested it would clear the position if the Branch Secretaries were made *ex-officio* members of the Council. They were the men who controlled the Branches (with the assistance of their Branch-Presidents and Committees), and they were in as good a position as anyone to represent the interests of the Branches.

The Chairman said the matter should receive consideration at the next Council meeting.

Lieut. Gordon suggested that the matter should be dealt with at the present meeting.

The Chairman said the Council could deal with it. If it were left to the Council it would be favourably considered.

The meeting then terminated.

MALLEABLE CAST IRON.—Messrs. F. Wüst and E. Leuenberger, in recent issues of "Ferrum," report on some experiments carried out by themselves in order to ascertain the influence of the time of heating, and the fuel used for heating, on the properties of malleable castings. The conclusions drawn are:—(1) Material cast from an oil furnace, owing to low sulphur content, is much superior to that from a cupola in elongation, contraction, and tensile strength. (2) With increase in time of heating, the tensile strength decreases at first slowly and then rapidly, while elongation and contraction correspondingly increase. (3) With increased time the toughness and resistance to shock are considerably increased. (4) Hardness decreases with increased time of heating. (5) With heating the specific gravity decreases, but the time has little influence. (6) Increased silicon content lowers the specific gravity considerably.

Sands, Cores and Drying.

The factors which require considering in a sand for moulding or coremaking are chiefly the following:—*Cohesiveness*, that the mould or core may keep its form. Refractoriness, that it may resist the fluxing effect of the metal's heat. *Permeability*, that it may permit the escape of gas from the mould or core. *Strength or toughness*, that it may resist the flow of metal.

These requirements, of course, are well known to foundrymen; but since they are not all obtainable to the maximum degree or even to the same extent in different sands, and as the importance of each quality varies according to the work to be done, a compromise must be struck in every case and the sand be modified to meet the work.

Refractoriness is associated chiefly with the silica content of the sand, since the fusing point of pure silica is very high. But natural sands are, with few exceptions, not pure silica, and contain a variety of other constituents. Even though many of these may not be of themselves bad, they may unite under heat with others present to form readily-fusible compounds, and thus lower the general refractoriness of the sand.

Moreover, even were natural sand composed solely of silica, it would be useless for moulding, owing to lack of cohesiveness and strength. The clay content of sand, however, provides the latter, and, provided it is not in excess or of a readily fusible nature, it operates advantageously. But it must not be sufficiently prominent to unduly reduce permeability, which it naturally tends to do, as it essentially lies between the grains of sand and closes the interstices in order to form a bond. A pure silica sand mixed with water has no cohesiveness. One with clay present and water absent also has none, though in this case the addition of water which is taken up by the clay renders the latter adhesive and gives it bonding power.

Cohesiveness of a sand thus varies according to the clay and water present, but there is for each given clay content a certain maximum which will give the best or strongest bond. This is a feature that requires careful watching, and, other things being equal, the best sand is that which has its greatest cohesiveness with the least water. The water creates steam if the mould is cast green, and this steam has to be expelled. If the mould is dried, there is so much longer time required to dry it, and the coke consumption therefore is higher. A frequent and unobserved waste occurs in the addition of too much water to sand, often by reason of insufficient working to spread the bonding material evenly through the grains.

Permeability, or the ability to pass gases through the interstices of the material, is well appreciated to be important. It is in a sense distinct from porosity as measured by the actual pore spaces, and depends on the relative sizes of the grains and the amount of bonding material. A sand with a large proportion of large grains lightly bonded usually has high permeability, while one composed of small grains is usually low in permeability; but a fine-grained sand, with fairly even-sized sharp particles, may bond well with a fair quantity of clay if evenly distributed, and still have a high permeability. On the other hand, a coarse sand with excess of bond badly distributed may be low in permeability.

Much has been written in the past on the value of chemical analysis of sands in determining their suitability for foundry use. Personally, I am inclined to largely discount its value from the practical standpoint. Mechanical analysis to determine the proportions of different sized grains is valuable as a guide to permeability; and for refractoriness the only reasonable and practical test is the thermal test. Practical experiment on the fusing or fluxing temperatures of a sample will tell the founder far more of what he wants to know than will any chemical analysis. He is not concerned with the geological or mineralogical titles of the constituents, however impressive they may sound. He wants to know whether the sand will stand the heat of the metal. A practical test as to the quantity of gas that will pass through the sand in a given time also is of very great value. Some experimenters have tried utilising the flow of water through a test specimen to determine the permeability, but that is not satisfactory, as the action of water on the constituents (the bond in particular) is not that of gas, and gives unreliable results.

A further feature in the examination of a sand is that a test is not useful unless the sand is rammed similarly hard to the ramming of the mould which it will form. A sand may have high permeability in a lightly pressed test piece, but be low when rammed hard in the mould. The pore space which gives permeability, moreover, must be evenly distributed, and this gives importance to the question of proper mixing.

As to the question of proper mixing, severe criticism has been raised at times against the old type of edge runner mill. It is still a popular apparatus with founders, and many men control the strength of the sand by the turn of the mill. But with some types of sand such mills are liable to create an excess of fine dust in the material, thus adding to its cohesiveness but also closing the pores. This criticism, nevertheless, can be carried too far, for the kneading effect of the mill and the consequent distribution of the bond in a better manner can easily be the chief function of a mill working on a good quantity of some sands, the actual amount of dust produced being relatively small.

Dust may result from either very fine natural particles of the sand, or from the burning of the clay bond by the metal in used sand. When the latter is ground off the particles in milling, it forms a dust which does not become a plastic bond with added water, but merely a dirt acting as a pore filler. This is the chief reason for limiting the amount of used sand in a mixture. If the destroyed or burnt clay were removed and only the silica left, an addition of clay would rejuvenate the sand. In practice, however, the sand contains other materials than silica and clay, and the result is that the fine silica particles often fuse together on the face of the mould when the metal is poured, the compounds thus formed being of low fusibility, and even if reground unsuitable as a constituent of the sand when it is used again. The impurities of sand include such materials as alumina, iron oxide, lime, magnesia, and the alkalies, all of these except alumina tending to reduce the melting point of the material. Quite appreciable quantities, however, are present in all mouding sands.

The fusibility of a sand is not in direct propor-

tion to the quantities of impurities present, and thus a simple statement of composition is of little use to the founder. The sand question calls for discretion and judgment on the part of the user, as regards its natural physical properties, and the selection of a sand for particular work; and in this he would be aided greatly by some ready means of testing the fusibility and permeability under working conditions.

Facing sands, of course, vary with the nature of the work, and may vary at different parts of the same mould, according to the intricacy or otherwise of the casting. But in any case facing sand should be cohesive, porous, and refractory. The toughness generally necessary for intricate parts is usually accompanied by less porosity than with a less tough sand, and, therefore, toughness has to be sacrificed for openness on large flat surfaces, where venting must be rapid. The practical formulæ often quoted, however, are not of much service, as they do not really indicate any particular nature of sand. For example, one writer advises for a strong, firm, and plastic sand for work which does not generate a large quantity of gas: 3 barrows yellow sand; 3 barrows red sand; 3 barrows black sand; 1 part coal dust to 15 of sand; mill, 10 to 15 minutes.

This is typical of many mixtures which are quoted, but unless the sands mentioned are more closely defined the formulæ is valueless. Of course, one founder may discuss mixtures in this way with another man in his own immediate locality and impart really useful information, by reason of both using the same red or yellow sands; but that is about the extent of the reliability of such information. To illustrate this may be quoted the colour and physical properties of a few sands which, while differing widely, might be indiscriminately classed as red sands:—

Industrial Research in the United States.

We have received from the Secretary of the Department of Scientific and Industrial Research, "Number One" of a series of Papers projected by the Advisory Council, and bearing on industrial research. It contains a fully illustrated report of Mr. A. P. M. Fleming on "Industrial Research in the United States of America," based on a visit to America last year. The report is divided into sixteen sections, is preceded by a short introduction, and has a good index. The author deals with every kind of industrial research as undertaken by (1) manufacturing corporations; (2) by associations of manufacturers; (3) universities and colleges; (4) national institutions; (5) commercial laboratories; and (6) scientific societies. He next discusses the questions as regards (1) endowments for scientific research; (2) the co-ordination of research in the United States; (3) the selection and training of research men; (4) the fundamental considerations in industrial research; and (5) the organisation of British industrial research. All these are fundamental questions which the author's experiences have raised in his own mind or which his readers will be likely to ask. To some of them he suggests answers which cannot fail to stimulate thought and discussion. Industry is the basis of national prosperity, and no stone should be left unturned to facilitate its progress. The instances adduced by the author show that in this respect research is of the utmost importance. The nation is entering upon a new phase in industrial and economic life, and its development will be governed largely by the extent to which new scientific knowledge is obtained, and is turned to the benefit of all concerned.

Name.	Colour	Strength.	Texture.	Vents at lbs. air pressure.	Began to fuse at deg. C.	Remarks.
Staffordshire	Very dirty reddish brown	Weak	Fine	4	1,300	Takes rather too much water. Works fairly well in moulds.
Nottinghamshire (Worksop) ..	Medium dark brick red	Medium	Fine	7	1,200	—
„ (Worksop Medium)	Light brick red.	Very weak	Medium size	3	1,400	Gritty. Works badly in moulds.
Cheshire (Roe Park)	Dark brick red	Very weak	Open	2	1,400	—
„ (Runcorn)	Light brick red	Medium	—	4	1,300	Works well and clean Requires little water.
Lancashire (Ormskirk)	Darkish red	Weak	Medium coarse	7	1,300	Dirty. Works badly in moulds.
Belfast	Light brick red	Medium	Fine	3½	1,200	Works well in moulds, but a little gritty.
Warwickshire (Birmingham Cemetery)	Very light to light brick red	Medium	—	4	1,300	Works soft. Requires little water
Cumberland (Carlisle District)..	Dirty dark brick red	Below medium	—	3	Nearly 1,400	Works somewhat sharp and gritty
Worcestershire (Stourport) ..	Light brick red	Below medium	—	1½	1,200	—
Devonshire	Reddish yellow to brown	Strong	Medium coarse	7	1,600	Works well in moulds. Evenly constituted

The foregoing results are from the tests by Mr. A. L. Curtiss.

The requirements of foundry work call for much more reliable tests of the physical properties of sands—tests that do not require the apparatus of the laboratory, but which can be conducted by any intelligent founder in the works.

AMERICAN BEEHIVE COKE OUTPUT IN 1916.—The official figures for 1916, just published by the U.S. Geological Survey, show that 35,464,224 tons of beehive coke were produced last year. This output represented an increase over 1915 of 7,955,969 tons, and was the greatest ever recorded in the United States.

The series is published by H.M. Stationery Office for the Department (whose address is Great George Street, Westminster, S.W.), and copies may be obtained of "Number One" for the low sum of 1s. net each through any bookseller, or direct from the Stationery Office or its selling agents.

MINERAL RESOURCES OF GREAT BRITAIN.—The Board of Agriculture and Fisheries has published a second edition of Vol. IV. of the Special Reports on the "Mineral Resources of Great Britain." In the main, it is a reprint of the first. Copies may be obtained through any bookseller, and from Messrs. T. Fisher Unwin, Limited, 1, Adelphi Terrace, London, W.C. 2. Price 9d.

The Manufacture of Manganese Steel Castings.

By W. S. McKee.

In this Paper, submitted to the American Foundrymen's Association, the author (who is connected with the American Manganese Steel Company, Chicago, Illinois, U.S.A.) deals with the manufacture of manganese steel castings in a general way. He lays particular emphasis, however, upon the difficulties confronting the manganese steel foundryman, and gives suggestions regarding the most accepted methods of solving certain manganese steel foundry problems. An abstract of the Paper is appended :—

Although the steel foundry industry has made tremendous strides in the past decade, the difficulties surrounding the manufacture of steel castings are scarcely less embarrassing at present than they were ten years ago. As fast as the problems standing in the pathway of progress are solved and removed, new perplexities arise owing to the enlargement of the field of operations.

The growth of the industry has led to specialisation, and at present there are several large steel foundries in the United States and elsewhere that concentrate their efforts on the production of high-manganese castings. On account of its peculiar properties, including remarkable resistance to abrasive action, manganese steel is used for a great variety of industrial purposes, and the shops manufacturing this material in the United States now have a combined capacity of approximately 70,000 tons per year.

Strange to say, however, the difficulties surrounding the manufacture of manganese steel castings do not seem to be as fully appreciated as those connected with the production of ordinary carbon-steel castings, possibly because they have not been as widely discussed. As a matter of fact, the manganese steel founder finds himself confronted with all the problems of the ordinary steel foundryman, plus a host of special complications arising from the peculiar physical and chemical characteristics of the material with which he is working. In order to achieve success it is necessary to have special experience all along the line, particularly with reference to melting and mixing the metals and heat-treating the castings. It is for the purpose of pointing out and discussing some of the peculiar problems of the manganese steel foundryman that this Paper is presented.

Manganese steel was developed originally in England, largely through the efforts of Sir Robert Hadfield. It has been manufactured on a commercial basis for nearly 26 years. The first manganese steel castings made in the United States were turned out in 1892. Originally it was considered impossible to make manganese castings successfully weighing over a few hundred pounds, but at the present time large rolling-mill pinions, crusher heads and similar castings weighing up to 30,000 lbs. each are being produced regularly, and it does not appear that the limit of weight has been reached by a considerable margin.

Manganese steel castings are used for a great variety of purposes, including parts for asphalt presses, ball mills, brick and tile machinery, cement kilns, Chilian mills, clay mills, coal-breaking machinery, coal-mining machinery, concrete mixers, copper converters, travelling cranes, crushers, dredges, gears, grab buckets, steam shovels, lifting magnets, rolling-mill machinery, stamp mills, etc. Manganese steel is also employed for the manufacture of safes, railway frogs and crossings, foundry tumbling barrels, etc.

As manufactured at present, manganese steel is similar in analysis to ordinary converter metal except that it is high in carbon and unusually high in manganese. In ordinary commercial castings the proportions of the latter metal range from 11 to 13½ per cent.

Manganese steel does not owe its wear-resisting qualities to its hardness. When subjected to the Brinell test, it shows an average hardness number of about 200. The extreme outer fibre of the treated steel shows a slightly lower hardness number than at a depth of about ⅛-in. From the latter point the hardness remains constant to the core of the casting. The lowering of the hardness at the surface is due to the oxidation of the carbon which forms on the surface during the heat treatment. The toughness of the material is due to its great molecular cohesion, which causes the particles to flow rather than to tear off. When tested with a scleroscope, manganese steel shows a hardness of from 40 to 50.

Manganese steel is non-magnetic and advantage is taken of this property in the use of this material for shields or bottom plates for lifting magnets, such as are extensively employed in foundries.

The shrinkage of manganese steel is excessive, amounting to 5/16-in. per foot as against 3/16-in. to ¼-in. in ordinary steel foundry practice. The high shrinkage creates a number of foundry problems. Commercial manganese steel generally contains from 11 to 13½ per cent. manganese, and from 1.00 to 1.30 per cent. carbon.

While a majority of the patterns used in manganese steel foundries are made of wood, it has been found advantageous to use metal where great durability is required, as in ordinary practice.

In making moulds it has been found that ordinary moulding sand and clay binders are unsatisfactory on account of the cutting action of the molten metal. Sands with a high percentage of silica are used and most of the moulds are oven dried. Special facing mixtures are required owing to the crushing effect of the shrinking manganese steel. An open facing which will yield readily is necessary, but at the same time sufficient skin hardness to prevent the mould from being washed away is required. Similar difficulties are encountered in providing proper core sand mixtures. These mixtures must be free venting; they must have sufficient strength to stand up properly under the destructive action of the molten metal, and at the same time the core must yield readily when the casting commences to shrink.

For melting the metal standard side-blow converters have been found satisfactory. At the Chicago Heights plant of the American Manganese Steel Company, two cupolas are provided for the primary melting of the metal and four three-ton converters are installed. The cupolas are situated on a mezzanine floor behind the converters and are so arranged that the metal may be drained directly from the cupola spouts into the converters. The ladle and crane equipment is similar to that found in the average steel foundry handling heavy work.

Manganese steel is a special converter metal to

which a quantity of ferro-manganese is added in the ladle. Standard 80 per cent. ferro-manganese is employed, and it is necessary to provide suitable facilities for melting this material. For this purpose either crucibles or specially designed reverberatory furnaces may be employed. If the latter method is used, considerable experience is required to design the furnace properly and to operate it successfully. The melted alloy is placed in the bottom of the ladle and the steel from the converter is poured in on top, enough ferro-manganese being used so that the castings will show about 12½ per cent. manganese when analysed. This is an average figure; the exact quantity of manganese varies somewhat with the nature of the work. The manganese acts as a strong scavenger, removing the gases and impurities from the metal, leaving it condensed and homogeneous. The production of slag is excessive, and before the moulds are poured the ladles are allowed to stand for a time in order to permit the alloy to perform its function and also to skim off the slag. The raw materials used in the production of the converter metal include low-phosphorus pig-iron and selected steel scrap, similar to those used in the ordinary Bessemer steel foundry. The same careful selection is necessary to insure uniformity in the finished product. The metal is handled and poured while very hot.

When the castings come from the sand they are glass hard, and before they are suitable for use they must be annealed. For this purpose furnaces of the proper size in which the temperature may be readily controlled are necessary, together with quenching tanks and suitable crane equipment for handling the hot castings. The annealing furnaces are of the ordinary open-flue type. Usually they are provided with cars on which the castings are placed for the heat-treating process. It is essential that as little time as possible elapse between the moment when the furnace door is opened and that when the casting is immersed in the quenching tank.

In operating the annealing ovens or furnaces it is necessary to heat the castings up slowly so as not to create expansion strains which will cause cracks. If the castings are heated rapidly the outside, of course, heats faster than the core, resulting in internal stresses of a serious nature. After the proper annealing temperature is reached, from 1,600 to 2,200 deg. Fah., the castings must be given a soaking heat for several hours in order to bring the molecules into a state of equilibrium. The time required for this operation varies from four to twenty-four hours depending on the size and character of the casting. The thickness of the metal which can be successfully annealed has gradually been increased until now castings with walls 5½ in. thick are handled without any great difficulty. It is advisable to have the water in the quenching tanks as cold as possible in order to cool the castings quickly, before there is any time for internal structural changes. The men drawing the castings from the annealing furnaces must be protected from the heat with special clothing and helmets. Respirators also are desirable owing to the noxious gases emitted from the furnace when the door is opened.

The proper cleaning of manganese steel castings presents many problems in itself. Very little sand adheres after the casting comes from the quenching bath. The metal is so tough, however, that practically all the trimming operations must be conducted by grinding. Extensive portable, electrically-driven grinding equipment is necessary for this purpose.

Electric Smelting.

Writing on the subject of electric smelting, Mr. T. H. C. Homersham, of Messrs. Thwaites Bros., Limited, Bradford, remarks :—The future of iron and steel lies largely with the amount of foresight shown and arrangements made during the next decade. The existing circumstances, entailing as they do an abundant supply of steel scrap of fairly good quality and a shortage of hematite and other irons, have pushed forward the use of electrically-operated furnaces for steel-making.

In the early days of the war I represented to the Ministry of Munitions the advantages that might be gained by putting down electric furnaces adjacent to generating stations which were not fully loaded, in certain areas in which large quantities of steel scrap were being made. Unfortunately I found that the mentality of those then responsible was such that they considered "electric furnaces" and "electric steel" something mysterious and experimental in character, and although we have now got rather beyond that point the whole problem continues to some extent to be surrounded by an atmosphere of mystery, brought about largely by claims that one or other of the growing number of "patent" electric furnaces makes the best steel, etc.! All such claims seem to me to be entirely erroneous, and the real problems which have to be grappled by the steel-makers and electrical engineers can, I believe, be summarised as follows :—

What is the maximum temperature and rate of heat input to which it is reasonable to subject various refractory materials, having due regard both to their thermal and physical properties?

What is the best method of applying and controlling the heat from an electric arc?

What form or shape should a furnace take to best save radiation losses and at the same time subject the refractory materials used to the least strain?

All of us who are using electric steel-making furnaces know that from any type of furnace in the market good steel-making results can be obtained, but the arrangements vary so much that a wider view of the whole subject should, I think, be taken than the mere comparison of one type of "patent" furnace with another. Of the queries I have formulated above the first appears to be the most difficult to answer, and is also perhaps the most important, but that we may hope for a general improvement by scientific investigation is apparent to those who have followed the recent discussions on refractory materials. My own knowledge of the subject does not permit me to go much beyond recognising that the ambitions of both the metallurgist and the electrical engineer are likely to continue to be limited for some time to come by the quality of the refractories at their disposal.

If the above surmise is correct, the next two queries become of paramount importance, as they both deal with every steel-maker's desire to get the best possible life, and consequently the greatest possible tonnage, out of his furnace linings.

As regards the question of application and control of the energy input, I believe that what the electro-metallurgist really needs and will eventually insist upon being provided with, is single-phase current, because he will discover that by taking the fullest possible advantage of the means afforded by the choking effect due to inductive resistance (usually termed "reactance") on a single-phase circuit he can best maintain that effective control of his current output so necessary to conserve his refractories and carry out satisfactorily his metallurgical operations.

As regards the form of the furnace, there can, I suggest, be little doubt that a furnace as nearly spherical in form as practicable, with two electrodes on the vertical centre line, provides the least possible radiating surface and the minimum amount of strain on the refractories. In a furnace of this form the further advantage is obtained that when cutting down a cold charge the charge itself serves to some extent to protect the walls of the furnace, as the cavity cut in it is itself a segment of a sphere gradually increasing in diameter.

The Seasoning of Castings.*

By Richard Moldenke, E.M., PH.D.

One of the little-known characteristics of cast iron, which nevertheless has an important bearing on results where accuracy in machining is essential, is the ability of this material to ease up internal strains when allowed to remain quiescent for a more or less extended period of time. It seems as if the molecules in such a casting, by virtue of their mobility, can adjust their relative positions to an extent sufficient to overcome some of the existing stresses.

The following instances will perhaps give a fair idea of the condition a casting may be in when just shaken out of the sand. A very large sheave-wheel, after shaking out, was taken outdoors to be cleaned and made ready for turning up. It was leaned against the side of the building, but before much could be done an arm tore apart with a loud report. Investigation showed that the sun had been shining on the upper rim, thus adding a slight strain to those already existing within the arm and thus over-balancing the strength of the metal in tension. Had this sheave been kept under cover for a while, or at least until machined, the strains would have eased off sufficiently to allow the sun to look upon it without disaster.

There are really two kinds of reduction in volume to be reckoned with: First, that due to the change from the liquid to the solid state; second, the reduction in volume after setting until ordinary temperatures have been reached. The first, often called "interior shrinkage," is a rather* serious thing. The specific gravity of molten iron is about 6.65, and does not vary widely from this figure whether the metal on setting be grey or white in fracture—all the carbon being combined when in the molten state. On setting, however, if grey iron results the specific gravity will be over 6.8, and if white iron, up to 7.8—the formation of graphite in the structure accounting for the comparatively moderate increase in the case of grey iron. In an average cast iron, with 7.3 specific gravity, the increase in density is 0.65, or 9 per cent.—which means a very big decrease in volume for equal weights of molten and solid metal. This situation accounts for the quantities of molten metal that have to be added to a mould after pouring it full in the first place, and in the case of small castings—particularly when of white iron—for the funnel-shaped sprue left in the pouring basin or gate.

Contrast this with the eventual reduction in volume after setting. Here we have a linear reduction of about 1 per cent. in every direction—an infinitesimal accomplishment as against the real metal shrinkage. It stands to reason that if the metal in setting has the power to pull apart whatever liquid material may remain after feeding has stopped, and thus give large spongy parts in the interior of a casting, there must be set up powerful strains which affect the strength injuriously. This is apart from the reduction of strength in the material for the section itself. In other words, not only will the metal have a smaller tensile strength because of the spongy nature of part of the section, but the interior strains counterbalance part of the tensile strength that is available.

This situation is intensified by the fact that the metal in setting does so far more quickly at the mould surface than in the interior—the cold sand walls drawing away the heat from the molten iron more quickly at the beginning of the setting process than later when this heat has to travel through a more or less thick shell of metal already set. The consequence is a higher percentage of combined carbon at the surface than in the interior of the casting. In the extreme case—that of chilling the surface—we have a white-iron surface and a grey-iron interior. The relative change in the specific gravities of the same molten iron turned into two extreme forms of iron as cast will indicate what strains there must be within the casting in question due to the differences in volume which the two metals want to occupy when set, but cannot properly occupy on account of the quickness of the setting action.

Finally come the strains due to the contraction in the set material until ordinary temperatures have been reached. This has been stated as $\frac{1}{8}$ in. to the foot in grey iron (about 1 per cent.) and $\frac{1}{4}$ in. to the foot in white iron (about 2 per cent.). In large castings this is very serious. Suppose, in the case of a big flywheel, the rim sets fast enough to hold the much cooler arm as in one set of jaws of a testing machine, the hub—held by the arms on the other side of the wheel—being the other set of jaws. Surely the arm in wanting to reduce in length $\frac{1}{8}$ in. to the foot (1 cm. per metre) must be under a terrific strain if not allowed to do so. In the case of white iron the situation is much worse, such castings as hand-brake wheels (subsequently annealed for malleable castings) snapping apart when allowed to cool in the sand in the ordinary way. Such work must be shaken out as quickly as set, taken to special ovens and allowed to cool down very gradually.

Fortunately, there are two phenomena which help to overcome some of the injurious strains set up. The first is the fact that cast iron—particularly grey cast iron—in the act of setting (between liquid and solid) can be stretched. The second is the before-mentioned "seasoning" or easing up of the remaining strains after the final contraction—through the mobility of the molecules. It is the stretching of grey iron during the setting that saves the flywheel arm from rupture before the new strains due to final contraction are introduced. It is the inability of white iron to stretch very much which makes for so many cracked castings in the malleable process which would not be seriously affected by the final contraction.

The foregoing should convince the man who is at least somewhat familiar with cast iron that it is unfair to the maker of the casting to judge its value by a test piece subject to a variety of strains introduced as the result of position, manner of attachment, method of pouring the metal, etc. It is further unfair to the purchaser—if he only knew it—to judge by attached test pieces, as there are many ways of artificially strengthening such test pieces. There is only one way of testing a casting properly, and

* From a Paper read before the American Institute of Mining Engineers.

that is to break it. Obviously this will not do, and hence for repetition work a given percentage of castings can be thus tested. For all other cases the only method of obtaining a reasonable assurance on the subject is the making of standard test bars, entirely apart from the castings but of the same iron, and making these test bars under conditions that give the iron the best possible chance to show just what it is, neither artificially strengthened, nor filled with strains and thus deliberately weakened.

This brings us to the real object of this note. Every mechanic knows that in planing up a slab of cast iron on both sides, to get a true job it is necessary to take a light cut, reverse, and take a cut on the other side, then reverse again for the finishing cut, finally reversing for the last cut. If this is not done there will be warped surfaces to deal with on account of the internal strains. Again, it is well known that to get a true piston is rather a difficult matter. Even after grinding to a finish it is apt to get out of truth. It is not so generally known, however, that if such a cast-iron plate or piston is allowed to remain in storage for a long period, the results will be much more satisfactory. The castings will "season." Where establishments are familiar with the situation, orders for castings are placed far ahead of requirements. Since, however, on getting to the bottom of a big pile the difficulty of tracing defective work becomes correspondingly harder, only shops having their own foundries are likely to do much storing.

For what seems the best indirect explanation of the "seasoning" action, we are indebted to A. E. Outerbridge, Junr., who in his experiments on "tumbling" castings to increase their strength, found that by the action of light blows, often repeated, the internal strains were relieved to such an extent that the real value of the metal came into play. The "mobility" of the molecules was aided by artificial means. Incidentally, however, the tests establish the mobility of the molecules in cast iron very satisfactorily. Replace half an hour's tumbling by six months' quiescence and the molecules will do their work with somewhat the same results.

Discussion.

Mr. A. E. Outerbridge, Junr., wrote:—The fact that iron castings improve with age has long been known. Many years ago the late Sir Frederick Bramwell, a distinguished engineer, formerly in charge of the metallurgical and gun-making department of the Woolwich Arsenal, determined to break up a large number of cast-iron mortars of an obsolete type that had been in stock for years. It was reported to him that it was found to be much more difficult to break these old gun castings under the "drop" than it was to break similar gun castings recently made, under his own supervision; he changed the composition of the iron and still found that whenever castings made recently were broken up (on account perhaps of superficial defects), great disparity was observed in apparent strength between the old and new castings. Sir Frederick then made many other comparative tests, such as heavily charging with powder and firing these mortars repeatedly until destruction occurred by fracture. In each such test he was surprised and mortified to discover that the old guns, made years before he assumed charge of the works, withstood many more firing charges than any of the new guns that he submitted to these tests. After thorough investigation he finally arrived at the conclusion that the difference in strength between the old and new guns was not due to inferior metal or methods, but solely to the seasoning of the castings, which had long been made and allowed to remain undisturbed. Sir Frederick stated that in his belief the cooling strains existing in the castings when new gradually disappeared in course of years, and the full strength of the metal in the castings was then secured.

In 1888 it was customary at the large machine-tool works of William Sellers & Company, Inc., to pickle all small castings, such as pulleys below a certain size, in large vats containing sulphuric acid diluted with water, in order to remove the sand. A hard and fast rule obtained at that time that such castings must not be cleaned in the tumbling barrels for fear of breakage. It was and is the daily custom to pour test bars from different portions of each melt of cast iron as it comes from the cupolas, and a card pattern was then made allowing 12 bars 1 in. by 1 in. by 15 in. to be cast side by side from one ladle of iron in one mould. These were all, of course, about the same size and quality and would break under nearly the same transverse strains under normal conditions. Four of these bars were cleaned with a scratch brush, four were pickled and four were cleaned in the tumbling barrel; all of the pickled bars showed about 10 per cent. loss of strength as compared with the companion bars cleaned with the scratch brush, while the bars that were "rumbled" all showed surprising gains in transverse strength, varying from 15 per cent. to more than 30 per cent. increase. This led me to undertake a long and elaborate investigation, covering several years, partly to ascertain the cause of these marked differences. The conclusion was that all iron castings are subject to cooling strains, and that these strains can be, in great measure, quickly removed by subjecting the castings while cold to repeated shocks or vibrations. The result of about a thousand tests of bars of cast iron of all grades, from the softest foundry mixtures to the strongest car-wheel metal, enables me to assert with confidence that, within limits, cast iron is materially strengthened by subjection to repeated shocks or blows. The rule at the Sellers' works was reversed so as to read that no small castings should go into the pickle tubs, but must be cleaned in the tumbling barrels. Pickling, indeed, has long since been discarded entirely in this establishment.

After publication of the Paper in the "Transactions," the Franklin Institute in 1896 appointed a committee of Science and Arts to investigate these discoveries, and they made their own castings. Their report, dated May 5, 1897, entitled "On the Molecular Changes in Cast Iron Caused by Vibration," was printed in the "Journal of the Franklin Institute," July, 1898. The report states "where the proper conditions are observed there will be a decided gain in strength in almost every case, at times running as high as 35 or 40 per cent. increase in the rumbled over the unrumbled bar."

A later development, which pleased me greatly, was the insertion of a new clause in the revised specifications for tests of iron castings prepared and adopted by the American Society for Testing Materials, to the effect that test bars must not be rumbled or otherwise subjected to shocks or vibrations before breaking, but must simply be cleaned of adhering sand with a scratch brush. This clause was inserted through the influence of

Dr. Moldenke. In 1904, at the Atlantic City meeting of the Institute, a Paper was presented, giving results of tests of extraordinary molecular movement of cast iron caused by repeated heating and cooling. Companion test bars that were cast in moulds 1 in. by 1 in. by 15 in. were there exhibited in which some bars had been caused to " grow " or increase in cubical dimensions over 40 per cent. without distortion or material change in appearance of the metal (unless highly magnified) as compared with untreated bars of the same original size.

The CHAIRMAN (MR. H. D. HIBBARD) said:—In addition to the internal stresses due to cooling from the casting temperature in the cases cited by the author, there are others which occur in certain kinds of steel articles, which may properly be considered with them in connection with seasoning. Thus, a piece of cold-drawn shafting if turned in a lathe will not be straight because the resultant of the internal stresses remaining is not the same as that of the stresses in the original piece. Again, a hardened steel shot contains internal stresses which may cause it to crack spontaneously, the most common case being that its point breaks off. This usually happens within a few weeks after hardening, if at all. In the castings and shot, the internal stresses are due to different rates of cooling of the various parts, as the surface always cools in advance of the interior and must do so unless the rate of cooling is infinitely slow. In the cold-drawn shaft the internal stresses are set up by the cold work done in drawing the bar through the die. How do these stresses compare, and are they to be lessened or eliminated by the same seasoning? If so, what seasoning is best? Will a permissible time alone do it at uniform atmospheric temperature? Probably not. Will time alone do it at some moderately elevated temperature, say not over 200 deg. C.? Possibly. Should the article be repeatedly heated moderately and then cooled? Probably. The daily fluctuations in temperature may be enough to effect seasoning in time. Old articles do not break spontaneously, nor presumably have excessive internal stresses.

The intensity of the internal stresses in a newly made or cooled article which seasoning might lessen are due to:—(1) The rate of the change of temperature; (2) the shape of the piece; (3) the bulk or volume of the piece; (4) the elastic limit of the metal; (5) the ductility of the metal; (6) the coefficient of expansion of the metal. It seems probable that heat, even if only of atmospheric degree, must be needed to effect the readjustment of the various parts of the article which results in diminishing or eliminating internal stresses. If, at any degree above absolute zero, heat causes vibration of the molecules, it seems reasonable to suppose that given a sufficient intensity of molecular motion ultimate positions will be such that each will be equally crowded or equally free on all sides, causing the annealed state which results in the greatest degree of softness and the highest specific gravity the metal is capable of possessing. Outerbridge's method of strengthening castings, which he calls annealing, by a succession of light blows may be founded on increased molecular movements, as the title of his Paper assumes. Iron castings have been seasoned by being kept for some days or weeks in a core-baking oven with the temperature fluctuating from atmospheric up to 110 deg. or even to 150 deg. C.

Some projectile specifications require that the hardened shot be heated to the temperature of boiling water. Those that pass this ordeal without cracking are not likely to break spontaneously thereafter. The reason may be either that the heating increases the internal stresses so that if a projectile is in a dangerous condition it will break then as a consequence, or that the heating if accomplished without rupture, by its annealing effect lets down the internal stresses so that the danger of spontaneous rupture is avoided. Delayed suicide of a shot when it occurs no doubt comes from fatigue of the metal, as it often happens when the temperature, and, therefore, also the stresses, are stationary. Stresses due to cold working may be less amenable to seasoning. The strength of wire is often due more to the drawing operation than to composition. Thus, wire for the cables of suspension bridges might be seriously weakened by seasoning if it took place to any considerable extent in a few years or even decades.

Book Review.

A Pocket Book for Chemists. By Thomas Bayley. Edited by Robert Ensoll.—London: E. & F. N. Spon, Limited, 57, Haymarket (7s. 9d. post free).

This is the eighth edition of this well-known pocket-book, now issued in the form of a handbook. The change in the size has enabled the editor to recast the whole of the book, and to alter the arrangement of the tables. Much obsolete matter has been omitted, many new tables have been added, and most of the old tables have been verified. The factors and tables in Section V. (Gravimetric Analysis), and Section VI. (Volumetric Analysis) have been calculated from the International Atomic Weights for 1915 and 1916. As the editor invites suggestions for increasing the utility and scope of the work, may we recommend for future editions a few pages on the analysis of pig-iron for carbon, silicon, sulphur, manganese, and phosphorus.

OIL-SAND CORES.—At a recent meeting of the Newcastle branch of the British Foundrymen's Association, a Paper on " Oil-Sand Cores " was read by Mr. J. G. Robinson, of Halifax. This Paper appeared in our issue of January, 1916, on the occasion of its presentation before the Birmingham Branch. In the course of the discussion, Mr. Matthew Gallon asked the author what his experience had been with regard to emulsified oil. Mr. Robinson said that by using emulsified oil he got better results than by using oil and water separately. This was due to the fact that the oil got better distributed over the sand grains when introduced as an emulsion. Mr. E. Smith, referring to castings connected with heavy marine cylinders, said he did not know any firm which used oil-sand where there was a great thickness of metal surrounding the core. In the case of a big marine cylinder, had Mr. Robinson any experience as to the resisting properties of the cores where the metal would have to be poured hot? Would it be advantageous to use oil-sand in that case? Mr. Robinson replied that he would have no hestitation in using oil-sand cores with any thickness of metal at all. He had used them with a body of metal 27 in. deep and 18 in. wide, solid metal, in a fly-wheel rim, where teeth had to be put on the outer rim. One must protect the core from the heat of the metal. A thick body of metal tended to burn the core and he advised coating with blacking and gas tar. With ordinary cylinders up to three and four tons he used oil-sand for jacket cores. In the case of big press blocks, however, if a founder were using a core which had proved satisfactory, it would not be advisable to depart from it. He would not advise experimenting with oil-sand, for instance, on an 80-ton casting.

The Pattern and Mould for a Slide Valve.

By Joseph Horner.

The illustrations herewith are those of the casting, pattern, core boxes, and mould for a double-ported slide valve. Fig. 1 is a plan view looking on the port face, Fig. 2 is a plan of the back, Fig. 3 a longitudinal section taken through the plane *a*—*a* in Fig. 1, Fig. 4 is a longitudinal section along the plane *b*—*b* in Fig. 1, Fig. 5 is a cross-section through *c*—*c* in Fig. 4, Fig. 6 is a cross-section through *d*—*d* in Fig. 4, and Fig. 7 is an end view.

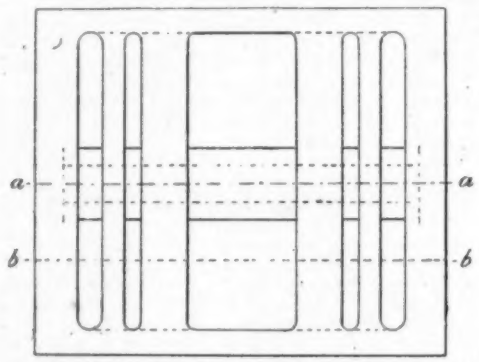


FIG. 1.—PLAN VIEW OF PORT FACE.

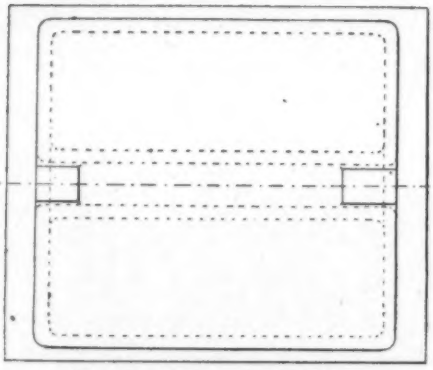


FIG. 2.—PLAN OF BACK FACE.

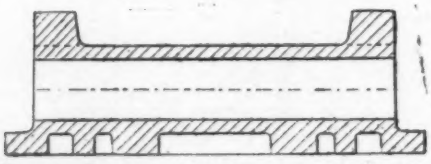


FIG. 3.—LONGITUDINAL SECTION *a*—*a*, FIG. 1.

This is an example of a hollow casting which cannot be made apart from the employment of dried cores. A good many articles afford the choice between the use of cores and of self-delivery, but this is not one of that class. This point need not be discussed, since the fact seems self-evident. No conceivable scheme of jointing in this pattern would enable it to be moulded without the employment of dried cores.

Figs. 8 to 10 show views of the pattern, Figs. 11 to 13 those of the core boxes. The pattern is shown in a face view, and in longitudinal and end elevations. Its method of construction is clearly indicated. Since the face A and the edges *a* have to be tooled, 1-8 in. is allowed on face and edges for planing or milling. For the purpose of ensuring spotless, sound metal on the face A, that is cast downwards. The locations of the ports are indicated by the core prints B, B; C, C; and D—compare with Figs. 1 and 3. As the inner edges of the ports have to be tooled, the prints in each are made about 3-16 in. narrower than the ports are intended to finish. The position of the hole for the valve rod is set by the core prints E, E; and since the upper portion of the mould has to be lifted from the pattern, the valve face being downwards, these prints, if made fast to the body, would tear down the sand in the spaces *b*, *b*. To avoid this is the reason why they

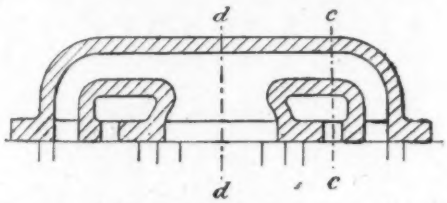


FIG. 4.—LONGITUDINAL SECTION *b*—*b*, FIG. 1.

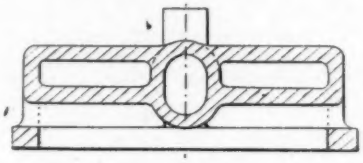


FIG. 5.—CROSS SECTION THROUGH *c*—*c*, FIG. 4.

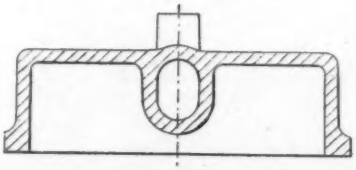


FIG. 6.—CROSS SECTION THROUGH *d*—*d*, FIG. 4.

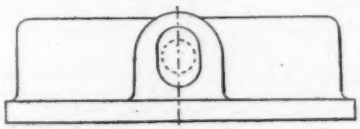


FIG. 7.—END VIEW.

are skewered on as shown, to be withdrawn into the mould in a horizontal direction after the mould has been lifted off the pattern. In a pattern so shallow as this is, no taper worth mentioning is necessary—less than 1-32 in. will suffice.

Three core boxes are necessary. The main box, Fig. 11, embraces the outer prints B, B, of Fig. 9,

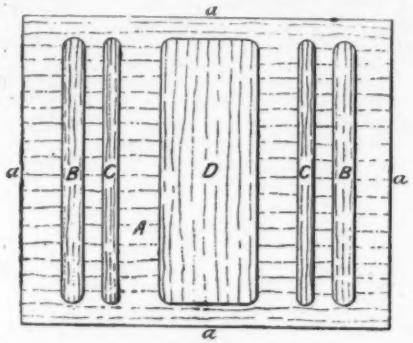


FIG. 8.—PLAN VIEW OF PATTERN.

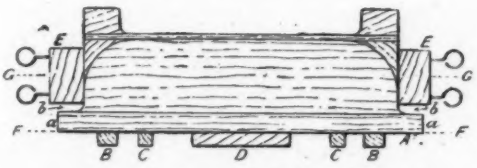


FIG. 9.—PATTERN IN SIDE VIEW.

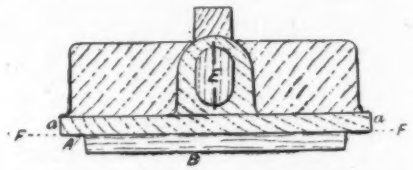


FIG. 10.—END VIEW OF PATTERN.

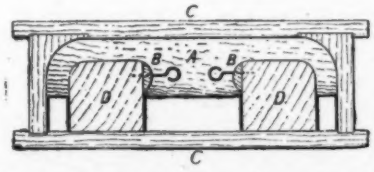


FIG. 11.—MAIN CORE BOX FOR PRINTS *B*, *B*, & *D*.

FIG. 12.—CORE BOX FOR PRINT C.

and the central one, D, with the corresponding arched passages—compare with Fig. 4. The second box, Fig. 12, is for the intermediate parts, located by the core prints, C. The third box, Fig. 13, makes the elliptical hole for the valve rod, fitting into the impressions of the prints E, E, in Fig. 9—compare with Figs. 3 and 6.

In the box, Fig. 11, the block A provides the thickness of metal round the valve-rod hole—compare with Figs. 1 and 3. The pieces B, B, left

FIG. 13.—CORE BOX FOR VALVE-ROD HOLE.

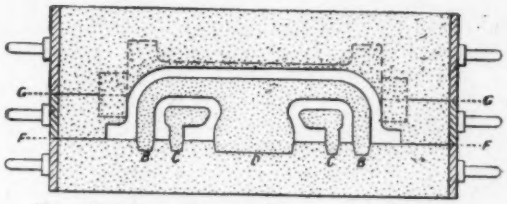


FIG. 14.—LONGITUDINAL SECTION OF MOULD THROUGH *b*—*b*, FIG. 1.

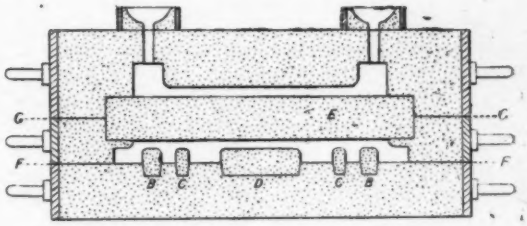


FIG. 15.—LONGITUDINAL SECTION OF MOULD THROUGH *a*—*a*, FIG. 1.

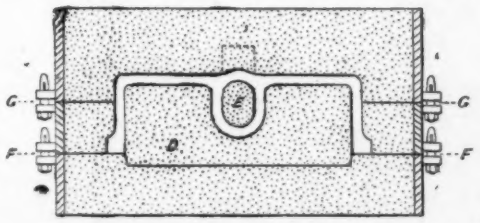


FIG. 16.—TRANSVERSE SECTION OF MOULD THROUGH *d*—*d*, FIG. 4.

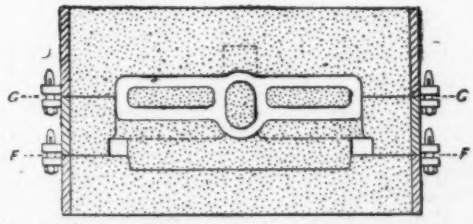


FIG. 17.—TRANSVERSE SECTION OF MOULD THROUGH *c*—*c*, FIG. 4.

loosely skewered correspond with the curved projecting portions in Fig. 4. They must be loose, because the sides, C, C, are unscrewed and drawn

away from the core after the core has been rammed, carrying with them the blocks, D, D, and A, and leaving B, B in the sand. In Fig. 12 the block A also gives metal round the valve-rod hole. The core made in this fits the prints C, C, in Fig. 9, and cores the shape seen in Fig. 4. The sides are unscrewed or unclamped and drawn apart. Fig. 13 is the box for the valve-rod hole, dowelled. Its core fits into the impressions of the core prints E, E, in Fig. 9.

Looking at the views of the pattern, Figs. 9 and 10, it is apparent that in order to withdraw it from the sand and to introduce the cores, it is necessary, though the pattern is not jointed, that the mould should be. There must be a joint at F—F, Fig. 9, in the plane of the face of the valve set, otherwise the port cores could not be inserted, and one at G—G coinciding with the centre of the elliptical core and its prints E, E, without which joint the core could not be inserted. An alternative might be a drop print, but that would be too troublesome in this instance. Consequently the boxes used must be three-parted, comprising, Figs. 14 to 17, top, bottom, and middle. The jointing planes lettered F and G correspond with those in Fig. 9.

In moulding, the face A, Figs. 8 to 10, is first rammed, the bottom box being therefore set uppermost at this stage. Vents are driven to the face of the pattern. The bottom is then turned over and laid upon a level bed of sand, which is vented. The middle is put on surrounding the pattern, the joint face F—F dusted with parting sand, and the middle rammed up to joint G—G, on which the top is then rammed. Top and middle are then lifted off the pattern, and the latter delivered, leaving the face A exposed. Cores C are put in place first, then the main core in print impressions B, B, D, then the elliptical core in print impressions E, E. The top is then lowered. The mould is shown in Figs. 14 to 17, comparisons between which and the previous views may be made. The core vents are all brought downwards through the bottom, except that of the elliptical core, which is carried out through the joint G.

Influence and Efficiency.

By James Edgar.

A great many positions of importance in industry are filled, or at least occupied, by men who are quite unsuited and unqualified for them. They have obtained their success through having "had a pull." In earlier days it did not so much matter if the mediocrity did become a nominal leader, but in these days when all industry, and perhaps more especially the engineering industry, has become so intricate, and is continually progressive, it is essential that the supreme intelligence should be at the top. Rapid decisions are necessary to avoid loss, and only the brilliant man can review a difficult position at a glance, visualise the probable results of a certain course of action, and make a prompt decision. In very few establishments are all the positions of importance held by men who have proved their capability for them. It is usually a just inference if a father and son have good jobs in the same firm that the father has exercised a natural desire to help his son. Most of us, however, think we are more clever than we really are, and invariably attribute our success whether rightly or wrongly to our own fitness for it. There is too much competition nowadays for any industry to carry passengers, and if the passengers are at the top it is ruinous. The country which in the days of stress after the war will achieve the greatest success will be the one that will sacrifice all other things to efficiency. "Efficiency first" must be the guiding motto right through our industrial system.

An unskilful manager or foreman cannot exact the discipline which is essential in a factory. The confidence and respect of his subordinates are necessary if they are to give of their best. If a leader exhibits or betrays an indifferent knowledge of his business, his power of control is diminished. It is not long before the output of his department drops. An inferior man generally attempts to make up for his failings by promoting others to be his assistants. Thus we sometimes see a works, or a department of a works, that ought to be supervised by one or two men, with a host of assistant managers. The tendency of this, of course, is to lower the workers' wages, to reduce the profits, and to limit the firm's prospects. The firms that have the lowest management expenses are the most successful competitors for work in the open market. In modern industry the man wanted is the one of tireless energy, full of initiative and enterprise, and a just disciplinarian.

The exercise of influence, however, is not always a bad thing. Without it a really good man may never get his chance. It is not always the best man who advertises his own worth, and it is not always wise to take a man at his own valuation. It would be well for industry if some system of a national kind were evolved by which a man's record could be consulted when applying for a position. A secret inquiry note system among employers is not suggested, but rather cards on which the man's grade could be recorded. A series of such cards, which would not be given an employee as a privilege after request, but as a legal right, would be the best testimony of his worth. At present reliance has to be placed on testimonials which are too often made out almost at the testatee's own dictation, and are consequently not always truthful.

One great advantage of such a scheme as has been suggested is, that it would give a chance to many men who are fitted for a better position, and, *vice versâ*, it would enable the employers to find them. It is very difficult at present for a man to get up the first rung of the ladder. It is natural for employers to be disposed towards a man who is experienced in organising and controlling men. Other things being equal, the experienced man is best. But oftentimes the new enthusiasm and zest of a tyro will more than compensate for lack of experience. And there are times when it will repay employers to gauge a man's worth by an interview and the possession of certificates of technical knowledge. It may seem risky, but it is not always possible for even a good man to gain that influence which supplies testimonials.

Mr. C. H. Ridsdale has now retired from the position which he held for over 34 years as metallurgical manager and chief chemist to the North-Eastern Steel Company, Limited, Middlesbrough. He has joined the firm of Messrs. Ridsdale & Company, metallurgical and consulting analysis of the same town, who specialise in the iron, steel and allied industries.

Electric Furnaces in United States Steel Foundries.

Information respecting some of the more recent developments in electrical steel practice in the United States is contained in the following abstracts of Papers read before American Societies :—

THE ELECTRIC PROCESS IN THE PRODUCTION OF SMALL STEEL CASTINGS.

In a Paper read before the annual general meeting of the American Electrochemical Society, held recently at Detroit, Mich., Mr. R. F. Flintermann (general manager of the Michigan Steel Casting Company) described the successive developments in the methods of producing steel castings at his works, and incidentally gave some particulars of what he termed the "reversed-duplex process," or the working of acid and basic furnaces in conjunction. At the outset he remarked that the castings they manufactured ran from ½ lb. up to 250 or 300 lbs. Some were made up to 2,000 lbs., but the average weight was about 20 lbs.

Our first method, he continued, was the crucible furnace. This was chosen because of the low first cost of installation and also because of the then generally accepted fact that crucible castings were of very high quality. The great difficulty with the crucible process was the crucibles themselves. They lacked uniformity, and were expensive. An average of three heats was considered good. Many crucibles would not come up to this average, and in order to save as much as possible the final additions of ferro-silicon and ferro-manganese were cut down to a minimum. The result was a steel of low manganese content, about 0.40 per cent., and, as a consequence, a steel which was not always deoxidised. The inability to keep the carbon low, because of the absorption of carbon from the crucible, was an added aggravation.

Our second method was the side-blown converter. This process enabled us to make larger quantities of metal at one time. The metal was uniformly hot and fluid and of fairly regular analysis. We were able to increase our manganese content and, consequently, were getting very much better results on physical tests. Our metal cost was much reduced. This was a distinct advantage, particularly since the cost varied little from month to month, while in the crucible it depended entirely upon crucible performance, over which we had no control.

Our third and very likely our final choice of method was the electric furnace. As regards the quality of the electric steel, there is no question as to its superiority over the converter metal. This applies to both acid and basic electric steel. It is only natural that this should be so if one compares the two methods. In the converter at the end of blow you have a mass of metal at a high temperature, covered by a highly oxidised slag, and the metal itself undoubtedly containing oxides. The addition of ferro-silicon and ferro-manganese at this point deoxidises the metal more or less completely, but it is still in contact with a slag carrying a high percentage of iron oxides, etc. In the electric furnace the covering slag is completely deoxidised before the ferro-silicon and ferro-manganese final additions are made. The metal is constantly giving up oxides to the slag during the deoxidising period, and is practically free from them before the final deoxidisers are added.

In our opinion it is the more complete absence of oxides in the electric steel which accounts for the superiority of this steel over converter steel. The results obtained on physical tests of electric steel are universally better. The great superiority of the electric steel lies in the fact that these results can be consistently obtained from every heat, which we were never able to do in our converter practice. The superiority of the electric steel was also manifested in the case of long, thin-section castings such as cross members on engine supports. Our loss due to shrink tears was much reduced when we were using electric steel. On one particular pattern we made 100 castings from electric steel, and found no shrink tears whatever. With exactly the same practice we found 20 out of 100 castings made from converter steel had slight tears or cracks, which had to be welded in order to save the castings. The reason for this behaviour is due, no doubt, to two facts:—(1) The lower sulphur content of electric steel; (2) the absence of impurities, particularly of oxides. The absence of oxides undoubtedly gave the electric steel a much greater strength at higher temperature, and this greater strength was able to resist the pull exerted on the steel during that period when the castings were shrinking or shortening. This behaviour of electric steel was true with both acid and basic steel, particularly with the latter, where we could maintain a lower sulphur. It was especially pleasing to have the higher quality steel without any increase in cost. Under present market conditions, with low-phosphorus pig-iron selling at an exorbitant price, the electric steel can be produced at much lower cost than converter steel. We feel confident that we can compete with converter steel even under normal market conditions.

Acid and Basic Linings.

At the present time we are using acid linings and bottoms entirely. Our reason for abandoning the basic process was the high and practically prohibitive price of magnesite. We found a very great advantage in the acid process. One great difficulty with the basic electric process is the slag. Our metal was poured from the furnace into a large coffee-spout ladle, in which the metal was taken to the pouring floors. The metal was poured through the spout into hand shanks, from which it was poured into moulds. In all cases the metal was skimmed by means of a metal rod skimmer when it was being poured into moulds in order to keep all slag back. In spite of all precautions we had much more trouble from slag in our castings than we had ever had from converter steel. With exactly the same pouring methods this slag trouble disappeared when we changed to acid steel. This was due to the greater refractoriness or higher melting point of the siliceous slag, which brought about a more complete separation of the slag from the metal.

The basic metal acted at times as though there were actually present in the metal a small amount

of slag in solution, which slag would finally separate as the metal lost its heat. In a number of tests which were made, when special precautions were taken to remove slag from the metal during the pouring, we still found slag spots on the machined surfaces of our castings.

"Reversed Duplexing Process."

The fact that with acid steel we have a minimum of slag trouble has led us to the conclusion that an ideal arrangement for a steel foundry would be to use a "reversed duplexing process" as it were. Part of the metal should be melted in a basic furnace, where it would be refined and sulphur and phosphorus eliminated in the usual way. The stock used in this furnace could be of a much cheaper grade and would more than offset the increased cost of rehandling the refined metal through the acid furnace as the next step in the operation. In the meantime the acid furnace has been working on a partial charge of steel, to which, when molten, will be added the refined metal from the basic furnace. The final deoxidisation under an acid slag can then be completed and metal withdrawn in the same manner as is done now. The writer believes fully that this "reversed duplexing" can be so timed and manipulated in two or more furnaces that the ultimate output of the battery of furnaces will be the same in any given period as though the furnaces were all running either basic or acid independently.

This method of "reversed duplexing" would have several distinct advantages for the producer of steel castings:—(1) The cost of part of the raw material would be much lower, since one could use a high-sulphur and high-phosphorus stock, as for instance screw-machine turnings, which bring a low price on the market and cannot be used in acid practice. (2) The basic furnace could be run at a lower temperature during refining period and the life of roof and walls would be much prolonged. The final temperature could be attained in the acid furnace, where we have no difficulty in securing necessary temperature and fluidity without injury to lining. (We run up to 300 heats without repairing roof or lining.) (3) We would be able to obtain lower sulphur and phosphorus in our acid steel without increase in cost; in fact the final cost might even be less. (4) Our metal would receive final deoxidisation under an acid slag. The advantage of this acid slag has already been emphasised, particularly the fact that it is more refractory and separates more completely. There is one further advantage. When the furnace contents are poured into the large ladle, the latter is immediately covered over with a congealed heavy slag crust, which keeps the air away from the steel and also keeps the steel hot longer. This is of great help where one is pouring a large variety of small castings, where fluidity and high temperature are most essential.

The writer believes this reversed duplexing process may be of great value in other products such as tool steel, piano wire, etc., where the absence of even minute slag particles is most desirable.

Without doubt the electric steel is purer and in consequence has within itself a minimum of impurities, which during the transition from the molten state to a solid mass would assume a gaseous form and cause blowholes. This much is granted as true. But, nevertheless, there is just as much cause for presence of blowholes in electric steel where the metal is poured into moulds as when the metal is made by other methods. The cause for such blowholes is not inherent in the steel itself, but is due to the methods of making the moulds and preparing them for the steel.

ELECTRIC STEEL.

Dr. John A. Mathews (President of the Halcomb Steel Company of Syracuse, N.Y.), in a Paper before the American Electrochemical Society, entitled "Comments on the Electric Steel Industry," gave the following reasons why the electric furnace, with proper handling, produces a superior product for severe requirements of automobile, aeroplane and munition manufacture: (1) Experience shows that chemical composition of consecutive heats can be held more closely to a standard than with any other process. This is most noticeable when handling easily oxidisable metals like vanadium, chromium, silicon and manganese. (2) It follows that less of these metals will have to be added to ensure a given final minimum, hence there will be less of the oxides of these metals produced in the steel and to be removed from the steel. (3) The more nearly composition can be controlled, the more certain are likely to be the results of subsequent heat treatment. (4) Electric steel is usually chemically purer than any other steel. Sulphur, especially, is readily removed. There has been considerable written of late to show that the effects of sulphur are not as harmful as generally believed. Be that as it may, when the sulphur is uniformly distributed, yet it is obvious that segregation of elements is impossible if they are absent. It also follows, if segregation of sulphur and phosphorus are not to be feared, the percentage of cropping may be reduced and the yield of sound metal increased. (5) Low sulphur in electric steel usually means a prior reducing condition favourable to complete deoxidation. This condition is favourable to sound ingots, freedom from blowholes and seams produced from them. Quiet metal has less tendency to segregate in the mould, as to either metallic or non-metallic elements, and produces steel free from "ghost" lines or laminations. (6) Alloy additions may be made in the furnace itself rather than in the ladle, which increases the chance of thorough assimilation, diffusion and homogeneity. (7) From a combination of the above reasons, it unquestionably results that electric steel is less easily injured by overheating than is the case with other steel. It will stand more heat in the forging or heat treatment without injury; that is, it has a wider safe heat range. (8) Electric steels are usually freer from slag and non-metallic inclusions than are Bessemer and open-hearth steels; (9) All of the above characteristics make for quality, when quality is the first consideration. The electric furnace possesses an economic value in its adaptability for handling and recovering alloy scrap values.

Dr. Mathews added:—In our plant we have grown from 500 k.v.a. to 5,500 k.v.a. of installed capacity for electric melting, while in the U.S.A. there is no less than 150,000 k.v.a. in operation or just been installed. The annual tonnage capacity of the furnaces using this current I estimate to be about 1,250,000 gross tons of ingots and castings. It is impossible to figure this exactly, because some furnaces may operate on either refining or cold melting charges, and, of course, the output is much greater when the former method is used. This infant industry already represents an output about eight times as great as the crucible-steel production and one-eighth that of Bessemer production.

High Air Pressures in Bessemer Converters.

MR. W. TRINKS, Professor of Mechanical Engineering of the Carnegie Institute of Technology, has contributed an interesting Paper under this title to "Blast Furnace and Steel Plant," from which we reproduce the following extracts:—

Practice has settled on blast pressures of 20 to 30 lbs. per sq. in. for converters, but calculations based on actual converters show that the ferrostatic pressure at the bottom of the vessel varies between 3 to 5 lbs. per sq. in., so that the question arises: Why the other 17 to 25 lbs.? For the purpose of solving this question a test apparatus was installed in the Mechanical Engineering Laboratory of the Carnegie Institute of Technology. One of the theories advanced for the necessity for the high blast pressures is the contention that the excess pressure is needed to keep the molten iron from flowing down into the tuyeres, but it is well known that air and liquid of equal pressure, filling a pipe, will arrange themselves so that the liquid is at the bottom. It has been claimed that the iron would flow back, if it were not for the very great speed with which the air flows upward through the tuyeres. In order to test this theory, the 6-in. pipe constituting the experimental converter was filled with mercury to such a height that the pressure at the bottom, that is to say at the mouth of the tuyere, was 4 lbs. per sq. in. The tuyere was 21 in. long, with a diameter of ½ in. The converter tube was righted from horizontal to vertical position with a pressure of about 10 lbs. per sq. in. The pressure was then gradually reduced, until the mercury ran back through the tuyere. This point was determined by the appearance of the mercury in a gauge glass under the tuyere, which did not take place until the pressure had been lowered down practically to that exerted by the mercury at the mouth of the tuyere, that is 4 lbs. per sq. in. The experiment was repeated several times by different sets of observers, and with different depths of mercury. The result was invariably the same, namely that the mercury did not run back through the tuyere until the air pressure equalled the static pressure of the liquid. It is therefore apparent that with openings as offered by the standard tuyeres (¼ to ⅜ in.) the high blast pressures now in use are unnecessary as far as preventing the running back of the iron is concerned.

And yet experience teaches us that high blast pressures are necessary for successful converter operation. Some information on the reasons for such necessity can be gained by watching the mercury in the Carnegie Institute installation while air is being blown through the metal. If the blast pressure is gradually increased, the behaviour of the mercury in the tube changes remarkably. With low pressures, say from 5 to 10 lbs. per sq. in., bubbles of air rise through the liquid, giving it the appearance of a liquid boiling in an open vessel. With 12 to 15 lbs. pressure, chunks of mercury fly up 2½ to 3 ft., but they are still compact. As the pressure rises to 18 lbs. or thereabouts, the mercury spouts at times to a height of 4 or 5 ft. The liquid is no longer compact, but is in the shape of drops anywhere from ⅛ to ¼ in. diameter. As the pressure is increased to 22 lbs., the drops become smaller, and at 30 lbs. the mercury is so well atomised that at times it appears like a grey mist of fine globules of metal. The spray of drops rises to more than 12 ft., and leaves the tube in the form of vapour almost. For reasons of health of the observers the pressure of 30 lbs. per sq. in. is not kept on the apparatus very long. Besides, the whole apparatus shakes violently at the high pressures, because practically the whole body of mercury rises and falls intermittently. It is evident from these tests that higher and higher blast pressures mean finer and finer subdivision of the liquid iron in a converter. Low blast pressures mean large bubbles of air which escape, before their oxygen has been entirely absorbed by the iron. Blast pressure should be high enough, and the subdivision of air and metal should be carried far enough, until the discharged gases are free from oxygen.

Converter practice then had to decide between large quantities of air at low pressure, or smaller quantities of air at high pressure. As we pass from low pressure to higher pressure, subdivision of air and metal becomes finer and finer, but the gain becomes smaller and smaller. Finally a loss appears, because first, blast pressures become excessively high, which fact means useless power consumption, and second, because too much metal is lost through the mouth of the converter. Practice has shown that the practical range extends from about 22 lbs. to about 32 lbs. per sq. in., depending upon the size of the converter.

The results of the Carnegie Institute tests, while made on a small scale, are nevertheless representative, because opening and length of tuyere coincide with those used in practice, and because the ratio of tuyere area to cross sectional area of converter is the same as used in practice, namely approximately three-fourths of 1 per cent. A slight difference may come in from the fact that the viscosity of molten iron probably differs from that of mercury. Furthermore tuyere length changes in practice, because tuyeres burn down from almost 2 ft. length to less than 10 in. length in six to eight hours. But none of these differences can seriously affect the mechanical effect of air of different pressures upon liquid metal.

THE OXYGEN JET IN THE STEEL FOUNDRY.—Tests on the cutting of the risers of steel castings with an oxygen jet were recently conducted by the General Welding & Equipment Company of Boston, U.S.A. Eight tests in all were made, and the results obtained are presented in the subjoined table, reproduced from "The Iron Age." Test No. 1 covered some 40 cuts, such as would be encountered in the general run of foundry work. These small risers presented greater difficulties than those of medium size, since they usually contain a considerable amount of sand and holes in the interior. The figures in this case include the oxygen wasted in going from one casting to another. The second and third tests were made on the same flywheel rim, but in test No. 3 hydrogen was employed as the preheating gas. Tests Nos. 5 to 8 were on a flywheel, which had been cleaned but superficially, and the risers, it is stated, dropped off easily at the completion of the cuts

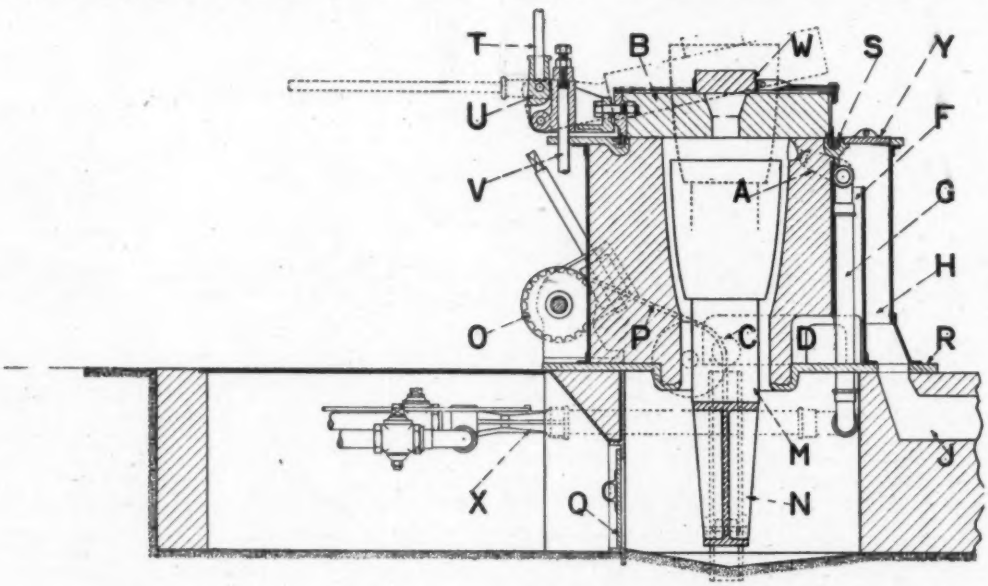
Test No.	Shape of cut.	Average thickness of cut, in.	Sq. in cut per cu. ft. of oxygen.	Sq. in. cut per min.	Linear in. cut per min.	Time, min.
1	Different shapes 1 to 5 in. thick.	2.50	2.84	—	—	—
2	Wheel rim 1¾ to 2½ in. thick	1.75	11.80	22.5	12.96	4.17
3	Same rim ..	1.75	9.67	18.3	10.45	5.50
4	6¼ by 8 in. ..	6.50	3.70	27.1	4.17	1.92
5	5 by 10 in. ..	5.00	2.78	20.0	4.00	1.50
6	5¼ by 15½ in.	5.56	2.50	22.8	4.14	3.75
7	5¼ by 15½ in.	5.50	3.04	26.2	4.77	3.25
8	5¼ by 16¼ in.	5.50	2.84	27.9	5.08	3.25

A New Design of Gas-Fired Crucible Furnace.

Recently gas-fired furnaces have received a considerable amount of attention from manufacturers of such apparatus, and, perhaps as a direct result, have come into more general use. This is probably more particularly the case with crucible furnaces. The advantages of gas-firing are obvious; at the same time, it must be admitted that in the earlier forms there were inherent defects which tended to some extent to negative the advantages. One by one, however, these defects have been eliminated, and in the best design of gas-fired crucible furnace we have a wholly efficient, convenient and economical unit.

The furnace which has been designed by Messrs. Jas. Keith & Blackman Company, Limited, and which our representative recently had an opportunity of seeing at their Holloway works, marks a distinct departure in crucible furnace construction. The distinguishing feature is the fact that it is fired from the top, the gas mixture entering the furnace tangentially by means of the nozzles A, which are also inclined in an upward direction, so that the flames strike the cover B, which consequently becomes very hot on the underside. The products of combustion afterwards pass spirally down the sides of the crucible, being discharged through the two ports C into the pre-heating ovens D on the base of the furnace body. These ovens serve to pre-heat the ingots, and their combined capacity is equal to that of the crucible. The chamber doors K have trays L attached to them on which the ingots are drawn out for convenient handling. After the gases have passed through these chambers they are then carried upwards by means of the flue F in such a way as to highly pre-heat the gas and air mixture which passes through the same flue by means of the pipes G.

A further unusual feature in the furnace is the arrangement for facilitating the removal of the crucible, and at the same time solving the difficulty of spilt metal, which is a source of serious trouble in the usual type of gas-fired furnace. The crucible is carried on a firebrick stool M, which in turn is secured to a cast-iron pedestal N, the pedestal being raised by means of the worm gear O and chains P on each side of the furnace, so that it may be lifted into the position shown by the dotted lines. The main object of this arrangement is to reduce the space around the crucible to the minimum, which otherwise would have to be left large enough to allow the tongs to be inserted more than halfway down the crucible. Such a reduction of space has an influence on the efficiency of the furnace in regard to fuel consumption. It will be seen that between the stool and the sides of the chamber there is an annular space which permits any spilt metal to drop into the pit below the furnace, which is sealed by the door Q, so that even should the whole contents of the pot escape by breakage the metal will simply fall straight through into the pit, and can afterwards be easily removed.



Elevation of the Keith-Blackman Gas-fired Crucible Furnace.

The furnace is constructed on a cast-iron bedplate R, which is set upon a brickwork pit formed with an extension in front to accommodate the gas mixture apparatus and to give access to the door Q. Normally the pit is covered by a chequer-plate. The cover B is formed with a lip round its outer edge, which dips into a sand lute, to prevent the products of combustion from issuing at this point. The cover is lifted by means of a simple tilting device, operated by the lever T and cam U, and can then be swung to one side on the spindle V. The inspection hole is covered by an auxiliary lid W.

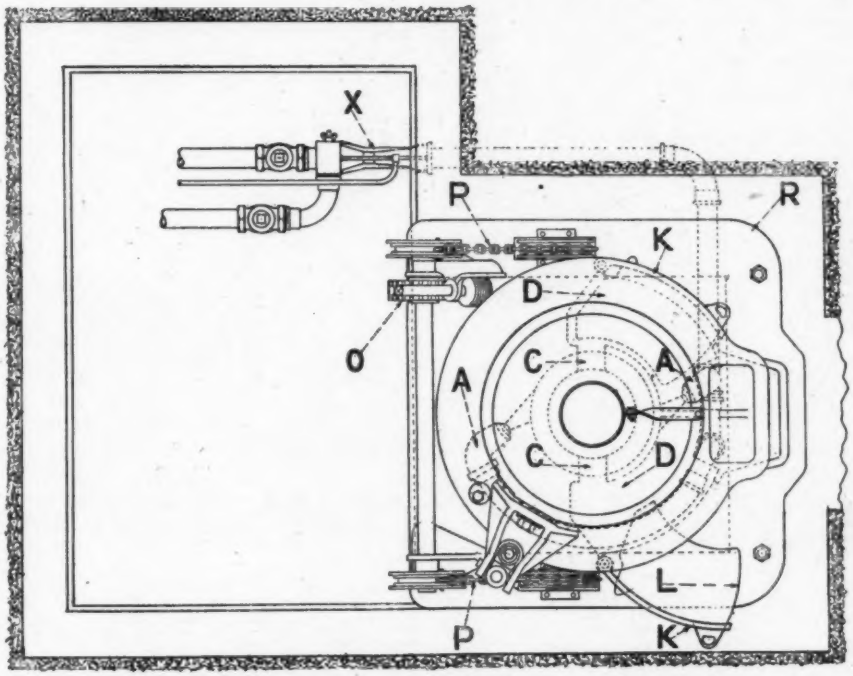
The gas and air are mixed at the injector X, and

controlled by means of the makers' patent automatic mixture control apparatus, the governor of which is placed outside the pit, where also the gas and air valves are arranged. An inspection door Y permits the flues F and H to be cleaned and inspected.

The advantages claimed for the arrangement of the furnace may be summarised as follows:—Its efficiency from the point of view of fuel consumption. For this the arrangement of nozzles are mainly responsible. The flame, by striking the cover, makes it incandescent, and gives practically a reverbatory effect directly on the metal, whereas in the ordinary method of heating from the bottom the heat has to be transmitted through the sides of the crucible, and the crucible at best is an indifferent conductor of heat. The method of heating also tends to lengthen the useful life of the pot, as it is found by experience there is considerably less danger of damage to the pot through flaking by heating from the top, and this may perhaps be attributed to the fact that the open rim of the top which receives the greatest heat is freer to expand or contract than the bottom of the pot. In any case it is obvious that a pot with a damaged top may be safely used a considerably longer time than a pot with an equally damaged bottom.

The provision for dealing with spilt metal has also important advantages. It will be appreciated that in the case of furnaces with a closed bottom, which are also fired from the bottom, any drops of spilt metal must fall into the zone of highest temperature, and a relatively small amount of metal will have a detrimental effect on the refractories round about the nozzle, whilst the location of such damage makes it more difficult to repair. In the event of the pot breaking it is possible the metal may fill up the whole of the bottom of the furnace, including the nozzles. Provision is made in some furnaces to run off such metal, but unless this is done in time serious damage and loss may result.

In connection with the furnace under notice, a system of forming the refractory lining has been devised which enables it to be easily and cheaply re-lined by practically unskilled labour, and at a minimum of cost for materials. The lining is formed of ordinary Sheffield ganister, moulded *in situ* by means of a metal former, the outside of which is the same shape as the inner contour. The lower end of this former is placed on the pedestal, and smaller formers for shaping the nozzle outlet and the outlets to the pre-heating ovens are placed in position. The wet ganister is then filled in. The nozzle formers are now removed and a sheet of paper placed over the top of the ganister. The lid is then lowered so as to rest on the paper.



PLAN OF THE KEITH-BLACKMAN GAS-FIRED CRUCIBLE FURNACE.

Whilst the main former is still in position the gas and air mixture is turned on sufficiently to give a low heat, and the whole mass heated up for about an hour. This operation bakes and consolidates the ganister sufficiently to allow the removal of the remaining formers, after which the whole of the gas mixture may be turned on and the lining thoroughly burnt.

EDWARD WOOD & COMPANY, LIMITED, Ocean Iron Works, Manchester, have forwarded a copy of their latest catalogue—a high-class art production—illustrating some of the various engineering works extensions they have recently carried out. This firm specialises in the design, manufacture and erection of engineering workshop buildings, and has established an office and branch works in Buenos Aires. A copy of the catalogue will be forwarded by the firm to any engineer, architect, or concern contemplating extensions.

Pulverised Coal as Fuel for Open-Hearth Furnaces.

Mr. James Wheeler Fuller, in a Paper read at the St. Louis meeting of the American Iron and Steel Institute, remarked that the only satisfactory type of burner for open-hearth furnaces is the one in which between 20 and 30 per cent. of the air required for combustion is driven at a few ounces pressure by a fan through the burner, and carries the coal from the feeder discharge into the furnace. At or near the nozzle of the burner a jet of compressed air is applied, which properly diffuses and mixes the coal and the air, so that upon entering the furnace the hot air, which is regenerated and which

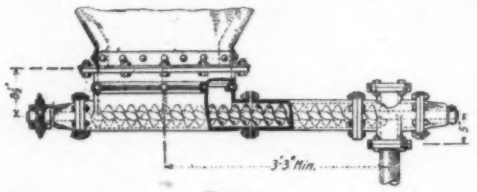


Fig. 1.

The pulverised coal feeder to the burner is provided with a long screw conveyor. The housing is bored to a neat fit to prevent any flushing of the pulverised coal.

is about 80 per cent. of the air required for combustion, can quickly surround each particle of coal with the proper amount of air for immediate and complete combustion. The nozzle on this burner is so designed that the direction of the flame is under control and can be forced to any particular portion of the furnace. With proper control of the flame in a powdered coal furnace it can be impinged directly on very large lumps of material, and will thus melt it immediately without the oxidation losses which are so frequent with other forms of fuel.

With the burner described there are three

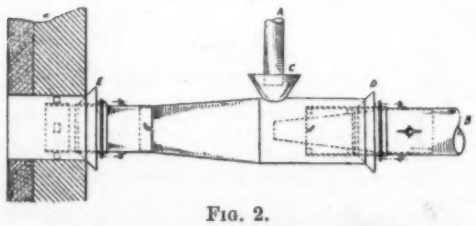


Fig. 2.

The pulverised coal is discharged from the feeding device into pipe *A*. Air from a fan at a few ounces' pressure enters from the pipe *B* and produces an injector action which draws the coal and air into the burner through the opening *C*. It also induces air at *D*, the amount of which is controlled by a cone fitted over the air pipe and arranged so that it can be moved to and fro, controlling the amount of air admitted. Any additional air required for combustion is induced at the point *E* under similar control.

methods of control: (1) the air from the fan, (2) the high-pressure air, and (3) the quantity of fuel delivered to the burner, which will give the furnace operator any desired condition in the furnace during each period of the work. This control is positive, and any change of conditions can be obtained immediately. The control is also such as to facilitate reversing the flame in the furnace. In a number of installations this is being done regularly with coal off less than 6 sec., thereby maintaining at all times a high uniform temperature within the furnace, which is hardly possible with other types of fuel over a long period of operations.

The application of pulverised coal as compared with producer gas in connection with a new installation is much in favour of the powdered coal, in that the first cost is considerably less. This, combined with other essential features, makes the cost of a unit about 40 per cent. under the cost of one using producer gas. There would also be additional savings effected in the furnace design and construction. For instance, the amount of regenerating capacity would be materially reduced, being only about 60 per cent. of that required with a producer-gas-fired furnace; for, with the gas fuel, it is necessary to regenerate not only the air, but also the gas; whereas, with powdered coal as a fuel it is only necessary to regenerate about 80 per cent. of the air for combustion. The roof, too, is simplified in construction, and there is no expensive port construction in the furnace.

One of the features now receiving considerable

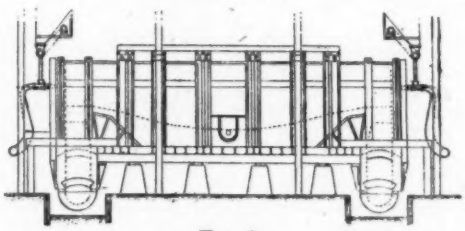


Fig. 3.

The volume of air, which is between 20 and 30 per cent. of air required for combustion, is supplied from a fan and is controlled by a blast gate inserted in the line. In the nozzle of the burner is inserted a jet of compressed air which serves not to increase the velocity of the coal and air entering the furnace but to mix the coal and air. The burner is supplied with a flexible nozzle to direct flame where desired.

attention is the proper design of the regenerative chambers so that they will not become clogged with the ash deposit from the powdered coal, and can be cleaned without hindering the operation of the furnace. This matter has already been successfully overcome, but further developments are under way, which all indicate that it is one which can be readily overcome and not hinder or prevent the application of powdered coal to this form of furnace.

Not only are economies effected in the consumption of fuel per ton of product, but there is also a material increase in the life of the furnace refractories; there is a regular, uniform high temperature, which is under the control of the operator; there is increased tonnage, and, in addition to this, the steel produced is of better quality.

From the number of applications of pulverised coal as a fuel, there is no limit, practically speaking, to the size of the furnace in which such coal can be burned successfully, as it has already been applied to open-hearth furnaces of 80 tons capacity, down to small heating furnaces of practically 1 to 3 cub. ft. contents, or having dimensions of 18 by 30 by 16 in.

In the discussion which followed the reading of

the Paper, it was mentioned by MR. J. P. KITTREDGE that after being installed for four 30-ton furnaces and in uninterrupted service for a time the equipment was further extended to serve three smaller open-hearth furnaces in another part of the plant. The entire open-hearth capacity of the plant was being operated with pulverised coal as a fuel and approximately 6,000 heats had been made to date. The time required to make heats was largely dependent upon furnace design, but there had been no difficulty in making heats with pulverised coal in the same time as they could be made with fuel oil, in practically the same open-hearth furnace. The large quantity of ash with which one had to contend offered by far the greatest problem to solve. With a comparatively small furnace, burning, say, one ton of coal per hour, 4 to 10 per cent. of such coal was non-combustible. To attempt to pocket or catch all this ash in the chequers would mean an unreasonably short life of the chequer chambers before clogging. This readily led one to conclude that a means of passing as large a percentage of the ash as possible through the chequers, and thence out of the stack, was the most logical course to follow. To reach this result it was also reasonable to assume that the effluent gases containing the ash should travel at a comparatively high velocity and with as few changes of direction as possible. Where the change of direction was unavoidable, such places should be accessible so that the deposited ash might be artificially agitated, causing it to be picked up by the draft and carried to the stack. It was important that no passage-way for the effluent gases through the chequers be allowed to become clogged, as that immediately tended to increase the deposit at such a point. The slag collected in the pockets of the pulverised coal furnace was considerably greater than that of the oil or producer-gas type, and it was important that arrangements be made to facilitate its removal by means of slag cars or otherwise.

According to another speaker, MR. N. C. HARRISON, the question of properly designed chequers and slag pockets was of vital importance in an open-hearth furnace using pulverised coal. To handle the accumulation, the furnace should be designed with removable slag pockets and blowers for the chequers. In the speaker's plant there were three open-hearth furnaces, making 50 tons per heat, using only cold stock. Two of these were producer-gas-fired, and the other fired with pulverised coal. This last furnace was built in December, 1915. As regards the fuel consumption on these two classes of furnaces, it was found that the pulverised coal furnace used from 100 to 150 lbs. of coal less than the producer-gas furnace per ton of ingots produced. As regards the life of the furnace refractories and the quality of steel produced, no appreciable difference had been noticed between the two classes of furnaces, although the increase of production secured by the use of powdered coal as compared with producer gas was very marked, the average time of heats being cut down by 1½ to 2 hours. Fifty-ton heats of 0.10 to 0.15 per cent. carbon steel had been made in the pulverised-coal furnace in little over 7 hours, and had averaged over a several weeks' run approximately 8 hours. The cost of an open-hearth furnace installation, using pulverised coal on one furnace only, might not be cheaper than a producer-gas furnace. But where a number of furnaces, at least three, were involved, the powdered-coal installation was undoubtedly cheaper than the producer-gas, due to the central coal pulverising building, which could be built at approximately the same cost for three furnaces as for one.

Illumination as a Factor in Manufacturing Costs.

We have received from the Westinghouse Cooper Hewitt Company, Limited, of 80, York Road, King's Cross, a booklet containing a Paper by MR. A. S. HUBBARD, under the above caption, in the course of which he remarks that the adequacy or efficiency of any sysem of illumination must be judged by the extent to which it enables the eye to perform its functions without undue strain and effort. The amount of illumination produced on a given surface from a watt of electric current, or 1,000 cub. ft. of gas, is of some interest and importance, but its importance is wholly secondary to that of the efficiency of the human machine in relation to the illumination by which it operates. Compared with the cost of labour and the value of the product turned out, the cost of producing artificial light is so insignificant a factor as to make its serious consideration ridiculous. There are certain general conditions which must be observed for all users of the eye, and other special conditions which pertain to particular uses; both of these must be duly considered in the choice of a luminant and the layout of a lighting installation. The general conditions are :—(1) Proper intensity, (2) absence of glare, (3) steadiness, and (4) freedom from injurious radiations. With regard to intensity, the eye can see very comfortably by an illumination of from one-quarter to one-half foot-candle. An intensity of such a degree should therefore be provided for passageways, store rooms, and other places where close eye-work is not required. For careful vision on light-coloured objects, such as reading on white paper, writing, etc., from two to four foot-candles are required, depending somewhat upon the age and individual condition of the eye. For careful vision on dark colours this intensity should be doubled at least, and where unusually careful vision is required several times this intensity is often used. These figures are based upon ordinary so-called "white light," or its nearest equivalent. The subject of glare is undoubtedly the most important single item in artificial illumination. Glare does not diminish with the distance as does intensity of illumination. Care should therefore be taken to keep bright light-sources out of the line of vision, no matter how distant they may be. Steadiness of light is so evident and necessary that it is rarely over-looked; a flickering light immediately irritates and tires the eye. With regard to freedom from injurious radiations, all light contains both visible and invisible radiations. The latter are of two kinds :—(1) Heat rays, and (2) chemical or ultra-violet rays. The latter by their intense action have a destructive effect upon certain tissues of the organs of vision. No commercial light-source at the present time gives as large a proportion of ultra-violet rays as is contained in sunlight, and ordinary lead glass, such as is used for incandescent lamp bulbs, tubes for mercury vapour lamps, and in the better grade of globes, absorbs nearly all of the ultra-violet rays. The danger, if any, is therefore insignificant.

All these general principles have been recognised since illuminating engineering became a distinct branch of science. It is only recently that another very important element has attracted attention, viz., the quality of the visible radiations. On this basis, all light sources may be divided into two classes :—(1) Those in which the luminous body is a solid; and (2) those in which it is a gas or

vapour. In the first class are included all forms of gas and oil lamps, and all forms of electric lamps except the mercury vapour, or Cooper-Hewitt lamp and the vacuum tube, or Moore light, and to a very slight extent the flame arc lamp. The light from an incandescent solid body contains all the different kinds of radiation that are found in sunlight, although not in the same proportions; in other words, it presents a continuous spectrum of colours, like that of the rainbow, which are accompanied by both heat and ultra-violet invisible radiations. The mercury vapour lamp differs from all other sources in giving no red rays whatever; the light is of a bluish-green colour, and by reason of its distinct colour it changes the apparent colour schemes of all objects which it illuminates. Its most remarkable feature, however, is that by it the eye can distinguish fine objects or details with greater ease and distinctness than by any other luminant in commercial use. Another peculiarity is its ability to render objects clearly visible at lower intensities of illumination than is possible with white, or ordinary light. The result of this peculiarity is that the shadows are much less dense in the case of such light than by that of any other light source. Again, objects can be distinguished at a greater distance by bluish-green light than by light containing red rays.

As stated at the outset, the cost of illumination is really of trifling importance; it may, nevertheless, come in for a share of consideration. The following table is taken from one of the latest and most authoritative works on illumination :—

	Intrinsic brilliancy, c.p. per sq. inch.	Watts per spherical c.p.
Half-watt	24.000– 30.000	0.7–1.0
Enclosed arc	10.000–100.000	2.6–3.0
Flame arc	5.000	0.28–0.5
Tantalum	1.100	3.1–3.5
Metal-filament	1,100	0.8–1.5
Carbon-filament	300–500	3.6 4.1
Silica mercury vapour	200–400	0.48
Cooper-Hewitt mercury vapour	10–12	0.77–1.0

Non-Ferrous Notes.

Iron Moulds for Casting Brass.—Discussing the kind of cast-iron used in making moulds for casting brass, the late Erwin S. Sperry stated that a hard, close-grained cast-iron does not give very good service, for the reason that it is too hard and soon cracks. The following is the analysis of a mould which gave particularly good service :—Graphitic carbon, 2.40 per cent.; combined carbon, 0.60 per cent.; silicon, 1.50 per cent.; sulphur, 0.11 per cent.; manganese, 0.46 per cent.; phosphorus, 0.29 per cent. The casting made from this iron had particularly long life as a mould.

Lime Crucibles for Melting Platinum.—For melting platinum, lime is said to be the most satisfactory material for the crucible, as it is one of the few materials that will stand the high heat of the blowpipe used for melting the metal in small quantities. The lime used is regular burnt lime. Large selected pieces are used, as free from fissures and foreign matter as possible. A lump is selected and a cavity is cut in it for holding the platinum. An oxy-hydrogen blowpipe supplies the heat. The molten platinum is allowed to cool in the lime, and the button of metal thus obtained is hammered, if necessary, until it is thin enough to enter the rolls for rolling into sheet.

Acieral.—This name is given to a new aluminium alloy recently described in "Iron Age." It contains 92 per cent. to 97 per cent. of aluminium, and is valuable on account of its strength and lightness. It is said to be non-corrosive, suitable for use in the manufacture of automobiles, aircraft, military equipment, hardware, etc. It is the discovery of Mr. de Montby; is silver white, has a specific gravity of 2.82 and a melting point of 1,382 deg. Fah. Its tensile strength in casting is given as 30,000 lbs. per sq. in., and in rods and sheets up to 64,000 lbs.; heat treated, its tensile strength is given as over 70,000 lbs. per sq. in. It is claimed that it may be sand cast, die cast with or without pressure, hot and cold forged, annealed, drawn, rolled, stamped, hardened by temper, polished, electro-plated, and soldered. It withstands the action of all acids except hydrochloric. It is manufactured in electric furnaces, and the plant at Orange Street, Newark, N.J., has a daily capacity of 10 tons.

Baume and Specific Gravity.—The following table shows the relation between the readings of the Baumé hydrometer and the specific gravity of the solutions in which it is employed. It is taken from "The Principles of Electro-deposition," by Samuel Field.

Degrees Baumé.	Specific Gravity.
3	1.020
6	1.041
9	1.064
12	1.088
15	1.113
18	1.138
21	1.166
24	1.195
27	1.225
30	1.256
33	1.289
36	1.324
39	1.361
42	1.401
45	1.442
48	1.485
51	1.531
54	1.578
57	1.634
60	1.690
63	1.750
66	1.815
69	1.885
72	1.960

Pressed Brass Castings.—Writing in the "Metal Record and Electroplater," P. W. Blair says :—"The problem of producing brass and aluminium parts which shall be more homogeneous, tough and perfect than can be produced by the ordinary sand castings, is an important one. Mr. Barnes, writing on the subject, says :—'The parts are found to machine more easily than parts cast by any known methods.' He says the 'cutting tools might almost be said to become sharper when using in cutting the pressed or forged metal. My experience has been the opposite. I have always found it very hard on the cutting edges of tools. I have tried different kinds of tool-steel on same high speed. The best results I have found in machining these brass parts after they have been pressed or forged is to put the parts through a process of annealing by allowing them to come to a temperature of 1,000 deg. Fah. After they go through this process you get satisfactory results in production, as they can be machined without the use of any fluid or lubricant, and the wear on tools is reduced to a nominal amount. Previous to machining these castings or forgings before being annealed, the wear on tools was very hard and production slow. Owing to the heavy hydraulic pressure which is applied to these parts to make them the desired shape or form, it has a tendency to make the brass when machining the same as cold rolled steel. I will admit that the metal has no tendency to cause the cutting tool to break or crumble. The tendency it does have is to take the edge off the cutting face of the tool. I have tried the method of pickling the casting after coming from the press to get the outside scale of oxide of iron, which is deposited on them, from going or coming in contact with the press dies. This process is of great help to machining, but the best results are obtained from annealing, where due care has to be exercised in getting an even temperature on the pieces."

Tungsten.

In the course of a Paper bearing this title, read recently before the Cornish Institute of Engineers, MR. H. W. HUTCHIN said that in order to produce ferro-tungsten, the crushed tungsten ore is mixed with a calculated amount of iron oxide or scrap, 10 to 12 per cent. of powdered quartz and 5 per cent. of rosin or pitch, and the mass placed in crucibles and smelted in a specially constructed furnace. A good commercial ferro-tungsten should have a composition approaching the following:—Tungsten 78.8 per cent., iron 15.9, carbon 3.2, silicon 1.87, sulphur 0.11, phosphorus 0.10 per cent. The maker of ferro-tungsten is very fastidious as to the purity of the tungsten ores; manganese, arsenic, and the base metals tin, copper, lead, bismuth, etc., are objected to. An alloy of aluminium and tungsten, known as Partinium, is largely used in the construction of the bodies of automobiles. The alloy is very light and strong.

The production of tungsten powder from wolfram is simple in theory, but difficult in practice. The chief points are (1) fusion of the ore with carbonate of soda, producing tungstate of soda, (2) solution of the sodium tungstate in water, (3) production of tungstic acid by addition of hydrochloric acid, (4) reduction of the tungstic acid to metal by heating with carbon. The fusion with carbonate of soda is done in a reverberatory furnace, lined with a hearth of dolomite agglomerated with tar and burned in place. After fusion the melt is broken up, granulated and digested with water in filter tanks, followed by methodic washing with nearly boiling water. The alkaline tungstate dissolves, also some silico tungstate, arseno and phospho tungstate. Soluble manganates are not very objectionable. To eliminate silica, arsenic and phosphorus, hydrochloric acid is added to the boiling solution to form para tungstate soluble in hot solution, but crystallising out when cold in fine prismatic crystals. Silico, arsenio and phospho-tungstates are more soluble and remain in the mother liquor. The paratungstate is transformed by addition of caustic soda to the normal tungstate, from which tungstic acid is precipitated by pouring the boiling solution into hydrochloric acid. To recover tungstic acid from the impure mother liquor calcium carbonate is added and the precipitated tungstate of lime treated by one of the methods applicable to scheelite.

Berzelius has suggested a modification in which the alkaline tungstate solution is saturated with sulphuretted hydrogen, then acidulated with hydrochloric acid. The tungsten is separated as the sulphide WS_2, which is dried and roasted to WO_3. Other processes have been suggested, of which a brief outline is given.

(1) *Process of F. Jean.*—The finely powdered wolfram is mixed with 3 per cent. of calcium carbonate and 20 to 30 per cent. of common salt, and heated for half an hour in a reverberatory furnace. The mixture, when cold, is powdered and treated with hydrochloric acid. Chlorine is usually liberated and the tungstic acid is left as a residue. The process is only applicable to pure wolfram since silica, cassiterite, etc. will also be left in the residue.

(2) *Gins Process.*—A mixture of wolfram and chloride of magnesium is heated at 1.200 deg. to 1.300 deg. C. on a dolomite hearth reverberatory furnace. In the main chlorides of iron and manganese, and tungstate of magnesium are produced in the reaction. The heat is continued with an oxidising flame to convert the chlorides of iron and manganese into peroxides. The residue is then extracted first with a small quantity of cold water to remove soluble chlorides, finally with boiling water to dissolve the magnesium tungstate. Ammonium carbonate in slight excess is added when the magnesium is precipitated as carbonate. The filtered solution contains ammonium tungstate which, when evaporated sufficiently, is deposited in crystals. The ammonium tungstate when heated is decomposed, leaving tungstic oxide.

(3) *Bisulphate Process.*—A muffle furnace with a hearth of silica agglomerated with pitch is used. The bisulphate is fused with the orifices of the muffle closed and then finely powdered wolfram is thrown in, continually stirred, and the temperature raised until the whole is fluid enough to run out. The mass after solidification is finely powdered and treated with water, soluble sulphates of the metals are dissolved and the tungsten remains as the insoluble potassium (or sodium) acid tungstate. Fifty per cent. bisulphate excess is used to ensure complete attack and to keep the solution sufficiently acid to ensure insolubility of the acid tungstate. The acid tungstate is dried and treated with warm water at 40 deg. containing ammonium carbonate.

It does not rigorously require tungsten free from carbon, and the carbide with 3 per cent. carbon may be employed in perlitic steels with a somewhat moderate tungsten content. For special steels for tool purposes containing in general more than 10 per cent. tungsten the carbon content is of much greater importance, but may be solved by the choice of a very soft steel, such as will keep the final carbon content under the requirements. To obtain uniform results the tungsten must be added in the form of pure metal or ferro-tungsten. Carbon must be absent in copper-tungsten alloys, as also in aluminium-tungsten alloys (partinium). In platinoid—Cu 60, Zn 25, Ni 14, W 4—the tungsten must be pure. For steel purposes there must not be more than 0.05 per cent. phosphorus, and not more than 0.1 per cent. sulphur. For high-speed tools not more than 0.5 per cent. manganese and 0.2 per cent. silicon.

TESTS OF SPECIMENS HARDENED BY THE WILD-BARFIELD PROCESS.—We have received an interesting report on tests recently carried out for the Hardness Tests Research Committee at the National Physical Laboratory on steel specimens treated by the Wild-Barfield process, the same as used for hardening screw gauges in large quantities for the Ministry of Munitions. The steel contained 1.5 per cent. carbon, and 0.49 per cent. manganese. Of the four specimens two (A and B) were quenched in cold water of 15 to 20 deg. C, after being heated to 10 deg. C. above the recallescent temperature before quenching, while the other two (C and D) were treated by the Wild-Barfield process. Unfortunately, specimens A and B had to be ground away in parts in preparing them for the testing machine. Consequently their worn surfaces, after removal from the testing machine, were found to consist of patches alternately highly polished and matte-like in appearance. The latter patches gave low numbers, while the former supplied high numbers in the scleroscope test, vitiating somewhat the comparisons. A truer comparison is furnished by the Brinell hardness tests, which were made on specially prepared flats. The numbers were 438 and 423 respectively for A and B, and 310 and 340 for C and D, that is lower; yet the resistance to sliding abrasion was higher for C and D (560 to 710) than for A and B (420 to 560). The sliding abrasion tests were made in the special machines described in the report of the Hardness Tests Research Committee of last November.

Brass-Foundry Notes.

By J. Peers.

The ability to prevent waste in the non-ferrous foundry is a matter of great concern to all manufacturers, owing to the high prices of raw materials. A good superintendent or foreman can save a great deal by using his materials carefully. It is customary in many establishments to weigh out the material from the stores, to prevent unnecessary waste, but this can be overdone, and foremen are therefore kept within very strict limits. A foreman could often prevent waste if he were allowed a freer hand in discharging his duties. Organisation, practice and costs should be worked in conjunction, instead of the rigid principles of cost keeping for each department, especially the foundry department, on too fine a scale. To take an example, certain castings were required under Admiralty specifications, of No. 1 standard gun-metal, Cu 88, Sn 10, Zn 2. The cost was not fixed, so long as the castings met the test. They were required to resist a 4,000 lbs. per sq. in. air and water pressure. They were two-way and three-way pipe connections. At the outset they were made according to the general run, but failed badly under the air test. Before any modifications were tried with the mixture, an increased pressure in casting was brought to bear on the metal, by raising the height of the bushes or cups—the wells that receive the metal when commencing to pour. This improved the results to a great extent, but did not obviate the evil. Another point that was noticed, and had a bearing on the case, was that the castings with the three-way connection were made with a loose core connected up to the body core; this loose core when placed left a sharp angle at one point, and although the core might be rubbed as carefully as possible, one could not put on the proper fillet to compare with all parts of the core.

Fluxes were next tried, as it was thought that the oxide in the metal was not thoroughly driven out, as nothing more could be tried in the method of moulding. Common salt as a flux gave very good results, but the life of the pots was reduced to about one-half the ordinary run of heats, and as this proved very expensive it was thought best to drop this method. About 4 ozs. of ground alum to every 100-lbs. pot was also tried; this also was a very good flux. Neither of the two fluxes mentioned, however, overcame the evil. Next the mixture was attacked, as no fault could be found with the moulding or melting, and requirements were met by adding an extra 1 lb. of tin to each pot, after the pot or crucible was drawn, and the whole well stirred. The increased depth of runners was still used, and the castings then came out to requirements. If in this particular foundry the materials had been weighed out for each melting on very strict lines, this practical way of overcoming the difficulty would never have been found.

The course followed in moulding at some brass foundries formerly (and probably still prevailing) was to have the top or highest part of pattern level with the drag or bottom part of the box; this always causes a lot of work when jointing down to the particular parts of the pattern, besides taking much longer time to produce work. This practice is followed to get a more solid casting, owing to more pressure being applied by the increased depth of runner. The same effect can be produced, and a good deal quicker, by increasing the depth of cope or top part; this will allow the joint to be made so that half the pattern is in the drag and half in top or cope. This top part is increased in the ordinary run of work by a wooden frame of the same size as the box, resting on the iron part of the box, and rammed up as one part. For heavier work two iron boxes may be bolted together. This method gives an increased depth of runner, and obviates the old practice of jointing down to the centre of the pattern. If no proper boxes are available and only one top part can be found, as often occurs in floor moulding, this practice of jointing down has to be resorted to in all cases.

When the wooden frames are used, and the class of work in hand requires a chaplet (copper) to hold down the core, the chaplet is cut so that it does not quite reach to the level of top part, and the sand cut away by the trowel, the chaplet pressed down on to the core, then a plate laid across, the plate being larger or smaller according to size of core to be held down. This plate is covered over with sand, and made solid to the top level of the box, and a flat weight is laid across to cover the whole of the mould, a space being left in the weight to fit round the bushes or cups. This is a very simple and effective method of weighting down core and box together when no bars are in the top part.

Nos. 1, 2, *and* 3 *Standard Gun-metal.*

	Copper.	Tin.	Zinc.
1	88	10	2
2	86	10	4
3	87	6	5

It has often been stated that there is very little difference between these three mixtures as regards tests. The actual case is that some superintendents can get as good results from a No. 3 mixture as another would get from a No. 1 mixture; but given equal conditions, it should never be assumed that No. 3 will give as good results where high pressure tests are carried out as the No. 1 will give. This is where a moulder's ability very often plays an important part. Therefore, although the melter may be a good man, also the mixture perfect, but poor results will follow if the moulding and gating are not in accord.

Another table is here given which may prove beneficial to those foremen who make up mixtures on the lbs. basis, and cannot grasp fully the percentage methods, or where less than 100 lbs. is required. Example:—Say 40 lbs. are required of No. 1 standard gun metal,

Copper	$\frac{88 \times 40}{100}$	= 35⅕ lbs. copper.
Tin	$\frac{10 \times 40}{100}$	= 4 lbs. tin.
Zinc	$\frac{2 \times 40}{100}$	= ⅘ lbs. zinc.
Total	... ...	40 lbs. mixture.

"Burning" has often to be resorted to, although it is much better if it can be avoided. The best way to burn a brass or gun-metal casting is to use a lead leaf. This lead leaf can be shaped to any contour of casting, and also forms a good fluxing agent; therefore it saves metal being used excessively, forms a neater job without heating too much area of the casting, and less stresses are set up in the casting. It also prevents the brittleness that is associated with most burns. For example, to burn a pipe connection, a piece of lead leaf is placed inside the pipe against the hole that requires burning, then sand is rammed up inside the pipe to make a solid foundation. The casting is then bedded in the floor, or better, in a box part, when the sand placed against it keeps in position better, and the part to be burned is placed in such a position that it comes at the side.

Against this hole is placed a thin strip of wood, and then another piece of lead leaf placed against the strip of wood; these are fitted so that they stand up about an inch higher than the hole, and sand rammed against them. After cutting a small channel for the surplus metal to run off, the thin strip of wood is drawn out, leaving a cavity to drop the metal in. The amount of metal used is judged according to thickness of casting. By adopting this method hundreds of castings can be saved that would otherwise be scrapped if the old method of burning by dropping the metal direct on the castings were adopted.

Copper chaplets are used in different sizes for general work, but for heavier types, such as dry-sand work, studs of the bobbin type are used. These can be made in the foundry in lengths of six or twelve, connected together by a short neck, so that they are easily separated. They are made from best bearing metal:—88 lbs. copper, 12 lbs. tin, 4 lbs. zinc, 2 lbs. lead. This mixture is for a 120-lb. pot.

A good mixture for electrical connections, termed red metal, is 64 lbs. copper, 2 lbs. tin, 4 lbs. zinc. It is as near copper as practicable for sound castings, and the best flux to use is 4 ozs. of ground alum.

Another point for brassfounders is the marking of runners with a certain mark for each class or mixture of metal. In some cases the moulder can put a certain mark on by his tools, but if a stamp be used to denote each particular mixture, the men that chip off the runners can easily distinguish what class of metal it is made from, and the scrap gates can be kept quite separate. This is quite a simple arrangement, but nevertheless hundreds of pounds will be saved in the course of a year; besides, when melting up scrap gates, the mixture can be gauged better.

ANTIMONY.—According to "Commerce Reports" issued by the U.S. Bureau of Commerce, China is the chief antimony producer. A few years ago antimony was a cheap metal, but the war has made the mining of the ore one of the most profitable mineral undertakings. The ore comes chiefly from Hunan, but Hankow is the active centre for its sale and shipment. The exports in 1915 included 21,326,000 lbs. of crude antimony (liquated stibnite), 4,310,000 lbs. of regulus, 455,333 lbs. of ore, 672,000 lbs. of ore refuse, 523,467 lbs. of oxide, and 2,240,000 lbs. of oxide refuse; a total of 29,528,400 lbs., against 25,661,867 lbs. in 1914.

Correspondence.

Effect of Silicon on Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—That silicon does *not* control, etc., etc., was the straight issue at the commencement of my paper (see page 73 of F.T.J.); and now that Mr. Rolfe has admitted that silicon does not control, etc., the controversy is ended.

Where Mr. Rolfe went wrong was in drawing his own conclusions from a later statement, thus possibly unwittingly side-tracking the issue. To have dealt with the point he raised would have led into an academic discussion on the modifying influences of chemical composition when x, y, and z conditions are constant, as is only possible in laboratory experiments; but nothing would give me greater pleasure than to discuss this side of the subject with him on another occasion. He might find we had many points of agreement as to effects, but we might possibly materially differ as to some of the *causes* of these effects.

Had Mr. Rolfe grasped the root principle which was discussed—as from your remarks on page 183 of April issue you have done—he would not have attempted to suggest my agreement that silicon did control. Manufacturing conditions control the physical properties of pig-iron—in fact control those analyses which are capable of variations in smelting operations. Smelting conditions are much more complex than the average chemist or metallurgist without blast-furnace training conceives.

Yours, etc.,

E. ADAMSON.

18, York Street, Sheffield, June 19, 1917.

Queries.

Air Furnace.

Can any reader give the writer a design with dimensions for a small air furnace to melt from 5 cwts. to a ton of brass? "X."

Specification for Cast Iron.

I should like some reader's opinion on the following specification of cast iron:—To be grey iron with a tensile strength of not less than 9 tons per sq. in.; transverse strength on 1 in. sq. bar by 12 in. to sustain a load of 1,000 lbs. at centre without breaking. The cast iron is not to contain more than:— 0.1 per cent. sulphur, 0.5 per cent. phosphorus, 1.2 per cent. silicon. The iron is to be cast in the form of light cylinders about 2 in. diameter by 6 in. long and 5-32 in. thick. The castings are to be used as covers for a delicate mechanism; one end is tapped about 1¼ gas thread. The above analysis has been handed to me as correct for this work, but in my opinion is quite wrong to fulfil the physical conditions as above. The physical conditions are comparatively easy and do not require such a low silicon and phosphorus and high sulphur. "T. B."

MR. W. R. THOMSON, of Messrs. David Rowan & Company, engineers, Glasgow, has been elected to the board of governors of the Royal Technical College, Glasgow, to fill the vacancy caused by the death of Mr. Andrew S. Biggart.

Properties of the Refractory Materials Used in the Iron and Steel Industry.*

By Cosmo Jones, F.G.S. (Sheffield).

Writers so rarely state exactly what they mean by refractory materials that a definition may not be out of place, even though its terms may not find general acceptance. As the metallurgical processes employed in the iron and steel industry involve heat exchanges, and high temperatures are necessary for most of the reactions that occur, special materials are required for the construction of the portions of the furnaces, ovens, and vessels employed that are exposed to high temperatures and are in contact with the solid liquid and gaseous substances taking part in the reactions. These special materials are refractory if they are capable of fulfilling the structural duties required while subjected to the high temperature necessary for the process employed, and are themselves unaltered during its progress. The conditions that prevail when metallurgical processes are being carried out vary so much, and the problems presented by the occurrence of slags sometimes basic and sometimes acid, of atmospheres now reducing and again oxidising, call for so many mutually exclusive properties in the refractory material employed, that only an infusible and non-volatile substance, with no volume change during variations of temperature, inert from a chemical standpoint, and with sufficient structural strength yet a non-conductor of heat, would be considered ideal. No such substance is known and very probably does not exist. Hence any refractory materials employed in the metallurgical art will be the nearest approach available to the ideal for the particular process employed. And as metallurgical processes are in practice conducted on commercial lines, the refractory material employed will be that which enables a given unit of final product to be produced at the lowest cost. Fused silica and platinum are useful refractory materials in laboratory experiments, but are excluded from consideration in commercial processes for obvious reasons. In practice, therefore, the refractory material selected is never ideal and always a compromise. The purpose of this communication is to discuss the properties required in any refractory materials employed, to point out their importance with a view to stimulating research, and to invite those familiar with the needs of the iron and steel industry to amplify or correct the suggestions made. It is hoped that any research undertaken can then be applied in the direction most urgently needed and where the most immediate beneficial results can be obtained. At the same time any advances in our scientific knowledge of the properties of available refractory substances, even if not immediately applicable, will be welcome as the foundation of later progress in practice.

Available Materials.—With the exception of carbon, and its compounds with silicon, which have a limited application, the available refractory substances are chiefly the oxides SiO_2, Al_2O_3, CaO, MgO, Cr_2O_3, or mixtures of these with oxides of iron, K_2O, Na_2O, and traces of other substances, regarded as impurities, some of which may function as catalysts. The materials available are therefore strictly limited; they never occur in a state of purity in nature. Their manufacture into refractory products involves in many cases sizing, agglomeration or bonding, and final heating to a temperature that varies according to the purpose for which the product is intended and the functions it has to perform. The problems that arise are not solved by a knowledge of the properties of the compounds mentioned; they are complicated by the presence of impurities and the varying nature of the bonding material employed. The final product, as delivered to the user, is always a mineral aggregate, often of great complexity. They possess no fusion point, but rather a range during which softening, at first incipient, at last, with increasing temperature, causes the material to fail to perform its functions. The constituents have varying melting points, and during heating they invert and new phases appear. Some inversions, involving serious volume changes, should be completed during manufacture, but often are not. This is not imputing blame to the manufacturer, for the temperatures required for such changes are rarely known, and even when known as a result of experiments under laboratory conditions, it does not follow that they apply to manufacturing processes. The art has been so long in front of the science of the refractory industry that the most urgent need at present is for an expression, in terms of scientific precision, of the most successful practice in manufacturing the refractory product and of the physico-chemical changes which take place when they are used.

Tenacity and Compressive Strength.—Tenacity and compressive strength at ordinary temperatures are valuable only in so far as they permit the refractory products to be transported and enable them to withstand the structural stresses to which they are exposed when used. This is not difficult to attain. It is when the material is exposed to high temperatures that the value of these properties becomes most important. The abrasion caused by the movement of solid substances while in contact with their heated surfaces is important, while the erosion caused by the passage of dust-laden gases at high velocities becomes serious in time. Little or nothing is known of the conditions that favour or retard abrasion and erosion. High tenacity, which in most cases would mean that of the bonding or of the most fusible constituent, is most probably the desired property. It is the surface exposed to the highest temperature which suffers, for it is the one that is in contact with the moving solids, liquids, or gases. Compressive strength is rarely a cause of failure, for the bulk of the refractory material is at a lower temperature than the face and therefore less affected There is, however, urgent need for accurate determination of the two properties under discussion at wide ranges of temperature for the more important materials under both oxidising and reducing conditions.

Corrosion Changes.—Not less important than resistance to high temperature with concurrent abrasion and erosion is resistance to the corrosion

* Paper presented before the Iron and Steel Institute.

caused by slags gases. The effect of acid slags on basic refractories and of basic slags on acid refractories are familiar, while a most striking example might be indicated on the marked corrosion of the silica bricks in the gas ports and uptakes in open-hearth furnaces, due to the alternating passage of oxidising and reducing gases with the resulting formation of fusible silicates. A factor conducive to rapid corrosion in the last case is the absence of large particles of silica in the bricks employed and the presence of excessive pore spaces. Here again little has been published and few observations recorded. The effect of the alkalies found in certain coals on the refractories are employed, viz., clay and silica. But while the contraction of the burnt clay is fairly regular with increased temperatures, quartz, which is the form of silica found associated with it in nature, has an inversion point at which it becomes trydimite. In the presence of certain compounds this inversion takes place at a temperature lower than that at which coking is carried on. In their absence the inversion is retarded and does not take place until a temperature higher than that usual in coking practice is attained.

Heat Conductivity.—If the refractory materials used possess a fusion point or softening range higher than the maximum temperature to which they are exposed, it would in most instances be desirable that they should be non-conductors of heat, for radiation losses would then be at a minimum. More often the prevailing temperatures approach and sometimes exceed that at which fusion or softening occurs. In those cases it is necessary to encourage radiation from the surface farthest removed from the heated surface, in order to cause a steep temperature gradient from the heated to the cooler face. In special cases cooling devices are necessary to prevent the rapid destruction of the material employed. Good conductivity for heat is most desirable where the material is used to form walls which transmit heat from the burning fuel to the contained charge which is being heated. The melting of steel in crucibles and the coking of coal are instances where a refractory material with good heat conductivity is required.

Schedule of Refractory Requirements of the Iron and Steel Industry. (Subject to Revision.)

Service.	Description of product.	Raw Material.			Difficulties experienced by users.	Directions in which additions to our knowledge might be sought for.
		Description	Former source of supply	Present source of supply.		
Coke ovens	Coke-oven bricks	Fireclay	Home and abroad	Home	Foreign clays were found more satisfactory in enabling a product to be made that gave gas-tight joints and resisted disintegration due to volume changes Attack by alkalies found in certain British coals	Description as complete as possible of the foreign clays found suitable and of the British clays that resembled them. Investigations of the cause of failure of coke-oven bricks. Influence of texture and firing temperatures on their durability in service.
Blast furnaces	Blast-furnace bricks	Fireclay	Home	Home	Abrasion and disintegration	Tenacity at high temperatures Causes of disintegration. Influence of texture and mineralogical character of original clays. Description of the available clays.
	Carbon bricks	Carbon	...	...	...	Texture and bond. Influence of these on tenacity and crushing strength at high temperatures.
Electric furnaces	Magnesite bricks	Magnesite	Abroad	Abroad	High cost. Low softening point. Variations in quality. Spalling if rapidly heated	Texture and bond. Firing temperature. Thermal analyses of magnesite from various sources. Properties of the burnt brick. Thermal analyses with quenching from high temperatures. Substitution of dolomite for magnesite for brick making.
Open-hearth furnaces	Silica bricks	Quartzite	Home	Home	Variability in quality. Erosion, disintegration, spalling	Texture, bond, and firing temperature. Mineralogical description of the fired brick. Thermal analyses of brick with quenching from high temperatures to determine actual constitution under working conditions.
Casting ladles	Nozzles	Fireclay, Magnesite	Home	Home	Erosion by liquid steel under certain conditions. Does not wear. Teeming speed lessens as weight and temperature of steel in ladle diminishes	Cause of erosion. Influence of texture and firing temperature on resistance to erosion. Influence of casting temperatures and quality of steel on erosion. Use of new materials.
Special ...	Chromite bricks	Chromite	Abroad	Abroad	Not largely used	Investigation of mode of occurrence of raw material in nature. Description and determination of properties of the pure minerals. Methods of concentration and purification. Bonding and preparation as refractory products. Properties of the finished product.
	Bauxite bricks	Bauxite	Home and abroad	Home and abroad		
	Zirconia and other rare earths	...	Abroad	Abroad		
	Fused magnesia & lime					

used in coke-oven construction is serious, and here too little is known as to the real nature of the destructive influences at work.

Volume Changes.—Every element or compound used as a refractory undergoes changes in volume during heating and cooling. Apart from the fact that these volume changes may, and do at times, cause disintegration with the consequent lessening of the useful life of the material, abnormal expansion causes structural difficulties, while contraction may be even more undesirable, permitting the passage of gases from one part of the furnace to another. In the case of coke ovens the retention of gas-tight partitions is absolutely necessary, and this involves the use of a refractory material which does not undergo appreciable volume changes. This apparent contradiction of the first statement simply means that a mixture of substances with volume changes of opposite sign

Texture and Porosity.—These physical characteristics of refractory materials determine in large measure their suitability or otherwise for particular duties. Owing to the complex nature of most of the materials used in practice, their properties are not those of the simple minerals of which they are composed, but the resultant of variations which are sometimes of opposite sign and are always varying at different rates. The relative size of the grains employed, the extent of the surface exposed by the more resistant constituents to the others used as bond or matrix, are most important factors in contributing to the ability of the material to perform useful service. Another point of some importance is the influence of mass in promoting or retarding inversions. Some of these inversions take place almost instantly once the critical temperature has been reached, but with others marked hysteresis occurs. Porosity must always occur when the refractory material is composed of more than one constituent, and where their chief volume changes are dissimilar or occur at different temperatures. Little is known of the effect of porosity on the properties of refractory materials. That the pores encourage the deposition of extraneous substances in the interior of the bricks, and that they render the structure permeable to gases, is of course obvious.

Stresses Caused by Temperature Changes.—The stresses causes by temperature changes are due to the volume changes which take place during heating. If the refractory material happens to be a good conductor of heat these are not serious, unless one face is rapidly heated and the distortion produced exceeds the tenacity of the material. The remedy available is to avoid rapid temperature changes, and whenever possible to raise the temperature of the material during the burning stage of manufacture well above that at which the inversion to the principal volume change should take place, and to hold it at that temperature long enough for the inversion to be completed. The "spalling" of magnesite bricks which sometimes occurs has been thus explained, and it is certain that the excessive expansion of silica bricks would be avoided if the manufacturer could ensure the completion of the quartz-trydimite inversion during burning. Despite the considerable advances in our knowledge of the inversions of silica made recently, their bearing on the problems that face the manufacturer are not yet sufficiently clear.

Need for Further Research.—Advances in the art of metallurgy are largely conditioned by the nature of the refractory materials available. The manufacture of these materials is based almost entirely on empirical rules and the experience of the men employed. Such rules are the result of experiences gained during a century or more by a rude process of trial and error, but where there were but very inadequate means of correlation. The methods employed to-day represent the survival of the fittest by the searching test of commercial success, but it by no means follows that they represent the best attainable. Further progress, if made at all, can only be slow and uncertain, and by consent it is now admitted that only by adequate and well-directed scientific research can such progress be accelerated. The first step—and in all probability the one easiest to take—would be to prepare specifications for the most important refractory products expressed in terms capable of precise measurement or description, basing the specification on the best current practice. This would only be following the excellent example of the gas industry. But specifications at their best only serve to stereotype the best current practice of their day. These specifications should be the starting point of systematic research which should cover, not only the problems that occur during manufacture, but the occurrence in nature and characteristics of the raw materials. Their concentration and purification, proximate and ultimate analysis, mineralogical description and thermal analysis are all points on which additions to our present knowledge would be of great value. But the refractory materials are so complex, and the problems involved are so difficult of direct attack, that any contributions to our knowledge of the properties of the pure minerals, or of the impure aggregates which are used in practice, would be welcomed, even if their immediate application did not happen to be possible.

The schedule of the requirements of the iron and steel industry, so far as the most pressing problems affecting the use of refractory materials, which is appended to this communication, is to be regarded as tentative only. Its most useful function will be to provide a basis for discussion, in the course of which it is hoped that corrections and additions will be made, and thus enable a reasoned statement of the requirements of the great industry represented by this Institute to be made.

NEW TESTS FOR MOLYBDENUM.—The usual test for molybdenum is to heat a small piece of the mineral (about half the size of a grain of wheat) in a porcelain crucible with a drop of sulphuric acid until the fumes have nearly ceased, and to allow the crucible to cool, when a fugitive deep blue coating will appear. Molybdenite, however, must be oxidised first by boiling it dry with two or three drops of nitric acid, or by powdering and roasting in the air for a few minutes. In a recent issue of the "Journal" of the Chemical, Metallurgical and Mining Society of South Africa, Dr. Moir communicates a test which secures a permanent blue colour. Hydrazine, N_2H_4, or hydroquinone, forms, in his experience, the best reagent for developing the blue colour. A solution containing a trace of alkali molybdate when acidified with acetic acid and treated with a little hydrazine sulphate and boiled, rapidly turns deep blue and retains this colour on boiling. An analogous but more remarkable reaction is that obtained when a slightly acid solution of MoO_3 is treated with potassium iodide (in some excess) and boiled for some time: iodine is slowly liberated, and the solution turns blue. The best known sensitive test for molybdenum, however, is that in which the acid solution is treated with sulphocyanide, and a tiny piece of zinc added, when a crimson colour is obtained in a few seconds. If iron is also present the solution becomes blood-red on adding the sulphocyanide, but on adding the zinc this becomes colourless through reduction to the ferrous condition, and after a few seconds becomes crimson if Mo is present. If the solution is strongly acid the colour verges to red, and is less sensitive; if nearly neutral it resembles the colour of permanganate. Another modification of the test for Mo in presence of Fe is to add stannous chloride to the acid solution until the yellow colour just disappears, and then add sulphocyanide. Another well-known reaction for MoO_3, in the absence of iron consists in adding potassium ferrocyanide. Mineral acid must be present, and a russet-brown precipitate is obtained which still contains hexavalent molybdenum. In the presence of acetic acid (not mineral acid) tannin (gallic acid) gives a similar reaction, which has been known for some time. Dr. Moir has improved this by substituting pyrogallol or pyrocatechol for tannin. Either of these when added to a molybdic acid solution previously treated with sodium acetate gives a very sensitive orange colour.

The National Physical Laboratory.

The annual meeting of the General Board of the National Physical Laboratory was held at the Laboratory last month. The President of the Royal Society (Sir J. J. Thomson) is Chairman of the Board, Lord Rayleigh being Chairman of the Executive Committee.

During the past year the Laboratory has been closely engaged, with a largely augmented staff (of whom more than one hundred are women), with a variety of researches and investigations arising out of the war, and has dealt with a greatly increased volume of test work for Government Departments. The Report of the Executive Committee for the year 1916-17 points out that the outstanding feature of the year has been the growth of gauge-testing work. Nearly the whole of the gauges required for the inspection of munitions are now examined at the N.P.L., the number averaging about 10,000 weekly. By arrangement with the Ministry of Munitions a new building has recently been erected to accommodate the work, the space otherwise available having become quite insufficient for the purpose.

In the Engineering Department progress has been made with some of the more important investigations in hand. In connection with the recommendations made in 1909 by the International Association for Testing Materials relative to notched-bar impact testing, tests have been made by the desire of the Engineering Standards Committee on the effect of varying the form of the notch. The research on hardness tests has been continued; the questions dealt with have included a comparison of the effects of dry rolling abrasion and dry sliding abrasion; a determination of the ratio of the Brinell hardness number to the Shore Scleroscope number; investigation of the relation between the Brinell hardness number and the resistance to sliding abrasion. The work on the fatigue resistance of materials under combined bending and twisting stresses has also been advanced. The Reynolds theory of the transmission of heat from surfaces to fluids flowing over them has been investigated for artificially roughened surfaces, and so far as the experiments have proceeded appears to be in accordance with the observations.

Problems relating to light alloys have largely engaged the attention of Dr. Rosenhain and his staff. Much valuable work has resulted from the rolling mill, and the steps necessary to render the results of this work fully available to constructors are receiving the most careful consideration. The Department of Metallurgy and Metallurgical Chemistry has been very fully occupied practically entirely on work connected with the war. Most of this is of a confidential character.

A proposal to arrange, in co-operation with leading metallurgists, for the standardisation of steel samples for use in analysis was approved by the Executive Committee, and the preliminary steps for the work are now under consideration by a Committee of the Iron and Steel Institute. It is suggested that the samples should be designated as "Standard Steel Samples prepared and standardised by the National Physical Laboratory in co-operation with a Committee of the Iron and Steel Institute."

The Alloys Research Committee of the Institution of Mechanical Engineers, who have for many years contributed largely to this branch of work, held a meeting at the Laboratory in November, 1916, and as a result an application was made to the Department of Scientific and Industrial Research for funds to provide a considerable increase both for buildings and equipment. To this the Department has agreed, and the Office of Works are now engaged in enlarging the foundry to double its original size. Meanwhile some theoretical work urgently needed for the understanding of practical results has been undertaken, mainly by lady members of the Staff.

Work on steels for automobile and aircraft construction has been carried out in conjunction with a Committee of the Institution of Automobile Engineers, and promises valuable results.

The investigations carried out have been, in the main, of a confidential character, and no details are given in the Report. It has only been possible to make progress with a very few of the researches undertaken prior to the war, and these are almost entirely closely connected with war problems.

REMARKABLE EXPLOSION IN AN ITALIAN FOUNDRY.—We have been requested to publish particulars of the following incident, and to ask our readers whether they can throw any light on the cause of the explosion, or refer to a similar accident. In an Italian foundry in which shells of semi-steel are being cast, a group of cupolas is served by Root blowers. On a recent occasion, after the cupolas had been set going with the natural draft, the electric starting switch of the blower was closed, whereupon a violent explosion took place, shattering the casing, but not injuring seriously the moving parts of the blower. The explosion was so violent as to displace several heavy tanks from their bases. The explanation offered by the management is that an explosive mixture had been produced by carbon monoxide finding its way from the cupola into the blower, and that the mixture was fired by a spark produced by friction by one of the rotors of the blower. The explanation seems to be feasible, but the possibility of an electric spark due to leakage is not altogether excluded in our opinion.

"VENCERA" COMPOSITION FILLETS AND VENTS.—We have received from Messrs. Cowan & Co., 62-63, Queen Street, London, E.C.4, particulars of their "Vencera" fillet, by the use of which, they state, it is possible to produce a perfect, neat and uniform fillet, which is cheap, simple, flexible and rapid of application. It requires no glue or cement whatever, being simply placed into position and rubbed down with the fillet tool, when it adheres firmly to the pattern. "Vencera" fixes equally well to either wood or iron, and is supplied in sizes ranging from 3-16-in. to 1 in. "Vencera" for venting has also been brought to our notice for use where (as, for instance, in cylinder ports) the vent holes must accurately follow the curve of the cores. The material is designed to allow the moulder to construct his vent channels to suit the pattern, free from the restrictions placed upon him by the fact that venting rods and wires must be so arranged that they can be withdrawn. "Vencera" merely requires to be placed in the mould or core wherever a vent-hole is wanted and is built in with the sand. As it has not to be withdrawn and is quite flexible, it can be made to follow any desired curve. It is of British manufacture, and consists of a wax composition built up on a very thin and perishable fibre. When placed in the drying stoves, it is stated, "Vencera" disappears from the mould without in any way affecting the porosity of the sand, and leaves a system of clean and perfect vent holes. There is no waste in cutting, as small pieces can be moulded together in a few seconds with the fingers. The sizes range from ⅛ in. to ½ in.

Trade Talk.

HADFIELDS, LIMITED, of Sheffield, have now acquired the patent rights for the manufacture of a new type of helmet.

MR. H. F. WILKINSON, lately trading as the Yankee Foundry Company, 99, New Road, Great Bridge, has been adjudged bankrupt.

A FIRE broke out last month at the Thornaby-on-Tees shipyard of Messrs. Gray, Taylor & Company. The damage was considerable.

A RECEIVING order has been made in connection with the affairs of George A. Smith & Company, consulting engineers, 61a, Pall Mall, London, W.

A FIRE occurred on June 16 at the works of the Morgan Crucible Company, Limited, Battersea, London, S.W., extensive damage being caused.

AN outbreak of fire occurred on June 16 at the iron-founding works of John Butler & Company, Limited, of Stanningley, considerable damage being done.

THE METROPOLITAN CARRIAGE, WAGON AND FINANCE COMPANY, LIMITED, have acquired the American interest in the British Westinghouse Electric and Manufacturing Company, Limited.

MESSRS. HARLAND & WOLFF will shortly conclude negotiations for the purchase of the controlling interest in the shipyards of Barclay, Curle & Company and Inglis & Company, situated on the Clyde.

MR. F. EVILL, London agent for the Klein Engineering Company (1908), Limited, and the Timbrell & Wright Machine Tool & Engineering Company, Limited, has removed to 159, Victoria Street, S.W.1.

Two special lectures dealing with the production and properties of malleable cast iron, in the light of modern needs and research, were delivered recently at the Birmingham University, by Professor T. Turner.

THE MINISTER OF MUNITIONS announces that he has made further orders under the Munitions of War Acts, under which 44 additional establishments have been declared controlled establishments. The total number of controlled establishments is now 4,942.

THE partnership heretofore subsisting between Messrs. J. Britland, A. Wass, J. Picken, and H. Huckstepp, engineers, Forncett Street, Sheffield, under the style of the Forncett Engineering Company, has been dissolved, so far as regards Mr. A. Wass and Mr. H. Huckstepp.

MESSRS. J. K. Catto, C. A. Mather, and F. S. Vosper, iron and steel merchants, 115 and 117, The Albany, Old Hall Street, Liverpool, and 6, Lloyd's Avenue, London, E.C., trading under the style of Catto, Mather & Company, have dissolved partnership, so far as regards Mr. C. A. Mather.

THE MINISTRY OF MUNITIONS point out that no new or second-hand machinery can be purchased, hired or transferred, without the sanction of the Ministry. It should be noted that no applications will be considered for the release of machine tools, whether new or second-hand, for class "C" work, or for work not essential to the conduct of the war.

VICKERS, LIMITED, have acquired from the Controller the business of the Bosch Magneto Company, Tottenham Court Road, London, W., and have formed a new subsidiary company under the title of the British Lighting and Ignition Company, Limited, of which they hold the whole of the share capital. The concern will manufacture magnetos under the trade name of "B.L.I.C."

WITH a view to removing misconceptions which have recently arisen in various parts of the country, the Minister of Munitions directs attention to the fact (1) that no building or construction work costing over £500, or involving the use of constructional steel, can be undertaken without a licence from the Ministry, and (2) that such licence is as necessary for work involved in the restoration of property destroyed or damaged by fire or aircraft as for work undertaken in other circumstances.

THE compulsory adoption of the metric system was the subject of a paper read before the Incorporated Society of Inspectors of Weights and Measures, by Mr. C. MacDonald (Glasgow), who said that at the beginning of the year the metric system was obligatory in trade in 38 countries, having a total population of 727,233,000. The metric system might be described as the standard system of the world and the development of foreign trade after the war would be facilitated by its adoption. Mr. H. Cunliffe replied in a paper opposed to the change.

THE attention of yacht owners, caretakers, agents, and builders, having yachts with lead ballast either inside or on keel, owned by them or in their charge, is directed to an order signed by the Ministry of Munitions dated February 1, 1917, instructing all persons having lead in their possession to send in to the Director of Materials, AM2/E/Hotel Victoria, Northumberland Avenue, W.C.2., a return of such lead. Yacht owners are requested to state name of yacht, approximate amount of lead inside and on keel, and where the yacht is lying. This return should be made immediately.

ARRANGEMENTS have recently been completed for the establishment of a new department of technical optics in connection with the Imperial College of Science and Technology at South Kensington, which will form part of a larger scheme adopted by the London County Council. The Government, including the new Department of Scientific and Industrial Research and the Imperial College, have decided financially to support the Council's scheme. The new department is under the management of a Technical Optics Committee, of which the Right Hon. Arthur H. D. Acland is chairman. Mr. F. J. Cheshire has been appointed head of the new department for a period of five years, with the title of Director of Technical Optics and Professor of Technical Optics at the Imperial College.

AN official notice has been issued by the Marine Department of the Board of Trade regarding shipment of ferro-silicon. The Board are informed that, after prolonged inquiry, no facts have been ascertained indicating that low-grade ferro-silicon made in a blast furnace is dangerous, and they are not aware of any reason why it may not be safely carried on board ship as ordinary cargo without any special precautions, excepting that a certificate be produced with each shipment stating that the ferro-silicon does not contain more than 15 per cent. of silicon, and has been made in a blast furnace. The Board are also advised that ferro-silicon produced in the electric furnace and containing not more than 30 per cent. silicon and the grade produced by the same method containing not less than 70 per cent. of silicon may be shipped under deck either in foreign-going cargo vessels or passenger vessels other than emigrant ships, but subject to certain conditions.

FOR many years developments on the north bank of the Tees have been regarded as most likely, but only in recent weeks have negotiations been completed which provide any immediate prospect of development in those reaches of the river which would materially benefit the towns of mid-Tees. Several times recently it has been hinted in public discussions that the South Durham Steel and Iron Company, Limited, of Stockton and West Hartlepool, were contemplating extensions, and last month the members of the Tees Conservancy Commission were apprised of the fact that the East Coast Steel Corporation, Limited, had purchased 21 acres of land at Portrack. Nothing definite has yet been published. All that has been done is for the East Coast Steel Corporation, Limited, to be formed and registered with its head offices at the offices of the South Durham Steel and Iron Company at Stockton, and to have purchased not only 21 acres, but 250 acres of land, extending from the Malleable Works to Billingham Creek for future contingencies.

THE subscriptions to the Ramsay Memorial Fund to June 14, amounted to £14,298. These include £1,000 each from Sir Hugh Bell, Bt., and Sir Robert Hadfield, Bt., £250 from Mather & Platt, Limited, £100 from Mr. Alexander Duckham, 50 guineas from Sir W. E. Garforth, and £50 from Dr. Dugald Clerk. The final form of the memorial will, in accordance with the terms of the main resolution passed at the Memorial Meeting, be submitted to the subscribers to the fund, and it will necessarily depend to a large extent upon the response which is made to the present appeal. The executive committee consider that there are two principal objects to which the larger part of the fund raised should be devoted, namely: (i) The provision of Ramsay Research Fellowships, tenable wherever the necessary equipment may be found, and (ii) the establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London. The execution of these two projects, does not, in the opinion of the Committee, preclude the utilisation of smaller sums for other suitable forms of memorial, such, for example, as the provision of a portrait for the National Portrait Gallery, or the placing of a bust or medallion in some suitable place, or the institution of an annual award of a Ramsay Gold Medal for Chemical Research.

ON June 14 the King and Queen visited the north-eastern counties, starting upon a somewhat similar tour to the one recently undertaken in the north-western centre of activities. Their Majesties started with Middlesbrough, visiting shipbuilding yards, dry docks, engine-building, and repairing establishments in the district. Sir Eric Geddes, Controller of Auxiliary Shipbuilding, was present to explain the necessary details to the visitors. Their Majesties were accompanied by Sir Hugh and Lady Bell, and watched with interest the various processes of manufacture. There were two specially interesting features of the river trip. The visitors saw three Swedish ships dressed in their honour, and almost immediately afterwards saw a party of German prisoners working on the slag heaps, having the flattering experience of being cheered by the foe. Among the many works visited were those of Smith's Dock Company, Limited; Messrs. Ropner; South Durham Steel and Iron Company, Limited; Wm. Gray & Company; Irvine Shipbuilding & Dry Dock Company, Limited; Richardsons, Westgarth, & Company, Limited; Messrs. Harkess & Sons; Sir Raylton Dixon & Company; North-Eastern Marine Engineering Company, Limited; Sir James Laing & Son; Wm. Doxford & Son; J. L. Thompson & Sons; John Cowan & Company; George Clark, Limited; Wm. Pickersgill & Sons, Northumberland Shipbuilding Company, Limited; Tyne Iron Shipbuilding Company, Limited; Sir W. G. Armstrong, Whitworth, & Company, Limited; Earle's Shipbuilding & Engineering Company, Limited; and C. D. Holmes & Company, Limited.

Control of Timber Supplies.

As the problems connected with the supply of timber have now only an indirect connection with the War Office, the War Cabinet have decided to transfer the Timber Supply Department from the War Office to the Board of Trade.

A separate department of the Board of Trade has been established for the control of all timber, and Mr. J. B. Ball, engineer-in-chief, London, Brighton, and South Coast Railway, whose services have been placed at the disposal of the Government by the company, has been appointed by the Board to take charge of the department with the title of Controller of Timber Supply.

All communications should be addressed to the Timber Supply Department, Caxton House, Tothill Street, Westminster, S.W., but the control of timber supplies in France will remain with the War Office, as at present, under Brigadier-General Lord Lovat.

Deaths.

MR. JAMES S. MORGAN, of the firm of W. Morgan & Company, engineers, Kilwinning, died suddenly on June. 4.

COLONEL H. L. BIBBY, of Messrs. Bibby Bros., copper smelters, was recently drowned through the sinking of a transport.

THE death is recorded of Mr. R. W. Gauntlett, late London office manager for Bruce, Peebles, & Company, Limited, of Edinburgh.

SURGEON ARCHIBALD M. RUSSELL, R.N. (drowned), was the only son of Mr. Thomas Russell, of the Coltness Iron Company, Limited, Newmains.

MR. WILLIAM THOMSON, late senior partner of William Thomson & Company, engineers, Kinning Park, Glasgow, died on the 10th inst., aged 67 years.

MR. MORTON MUIR, of the firm of Morton Muir & Company, iron and steel merchants, Glasgow, died at Riversdale, Barrhead, on May 27, aged 57 years.

MR. J. LLOYD, for a number of years secretary to Sir James Laing & Sons, shipbuilders, Sunderland, died on June 20, aged 76 years. Mr. Lloyd retired in 1906, after 46 years' service with the firm.

MR. J. R. PORTER died, after a long illness, at his residence at Hull on June 19, at the age of 57. When quite a young man the deceased was for some time employed at the Kirkstall Forge, Leeds. About twenty years ago he was appointed manager of the Hull Wagon Works, and afterwards entered into partnership with Mr. J. Whittingham. The firm of Whittingham & Porter, general engineers, of the Victoria Ironworks, East Hull, attained an excellent reputation, and after the dissolution of partnership, five years ago, Mr. Porter carried it on alone.

CAPTAIN W. B. STEWART, killed in action, was on the staff of William Beardmore & Company, Naval Construction Works, Dalmuir, previous to the war. Captain Stewart was a son of the late Mr. Duncan Stewart, engineer, Glasgow, and a nephew of Sir Wm. Beardmore, Bart. On the firm of Messrs. William Beardmore & Company taking over the works of Messrs. Robert Napier & Sons, Govan, he began to serve his apprenticeship to shipbuilding and engineering there. Since the formation of the works at Dalmuir he has been associated with their development.

THE death took place on June 3 in Glasgow of Mr. Joseph Russell, shipbuilder, of Seafield, Ardrossan, and The Knowe, Port-Glasgow, in his 84th year. Mr. Russell, who was connected with Clyde shipbuilding for over half a century, was born in London, and served his apprenticeship at Renfrew. Thereafter he was for some time in an Ardrossan shipyard, and subsequently became connected with the firm of Laurence Hill & Company, Port-Glasgow, whose yard is now occupied by Messrs. Dunlop, Bremner & Company. On the dissolution of the firm Mr. Russell returned to London, but not long after renewed connection with Port-Glasgow, when in 1874, in company with the late Mr. Anderson Rodger and Mr. William T. Lithgow, he established the firm of Russell & Company, their establishment being known as the Bay Shipyard. A dissolution of partnership took place in 1891.

THE death is announced of Mr. J. M'Skimming, commercial manager of the Steel Company of Scotland, Limited, which took place at his residence, Norwood, Bothwell, on June 15. Mr. M'Skimming was born near Motherwell, and throughout his commercial career was connected with the Scottish steel trade. As a boy he entered the employment of David Colville & Sons, Limited, Motherwell, with whom he remained for about 25 years. He took an active part in the introduction and development of the manufacture of mild steel by Messrs. Colville. After leaving their service Mr. M'Skimming was for about 10 years commercial manager to the Lanarkshire Steel Company, Limited, and a little over six years ago he became commercial manager to the Steel Company of Scotland, Limited. At the time of his death he occupied the position of chairman of the Scottish Steelmakers' Association.

Legal.

High-Speed Steel Returns.

An interesting case was decided at Sheffield on June 11, when Bennett & Company, Limited, of the Self Hard Steel Works, and Mr. W. F. Heslop, the managing director, were summoned on sixteen counts for making false returns of their manufacture of high-speed steel, and also making sales of the same which had been prohibited by the Ministry of Munitions, and were therefore unlawful.

Counsel, on behalf of the Director of Public Prosecutions, explained that three summonses charged the firm with having in the months of September, October, and November last returned their total production at less than what the books really showed it to be. The summonses for unlawful sales related to transactions which took place after action had been taken with the firm on October 26. On that date a letter was sent by the Ministry to the firm, expressing astonishment at the latter's conduct with regard to the export of high-speed steel, when export had been suspended, and announcing that in view of this the department had no alternative but to decline to supply tungsten, and informing the firm that they had not to negotiate for any further orders for the sale of high-speed steel for home or export consumption. Whilst the embargo was on the firm accepted an order from another Sheffield firm, on the condition that the purchasing firm should agree to have the order ante-dated to a time prior to the receipt of the letter from the Ministry. By this means they executed the order contrary to the order of the Ministry. Other orders were executed during November and December for other firms in Coventry and other parts of the country which should not have been.

A representative of the Ministry stated that action was taken against the firm in order that the Ministry should know where they were in regard to deliveries of high-speed steel for Russia. These were urgently required, and no tungsten could be afforded to be wasted in other ways. It was felt that the firm were not putting the interests of the country before their own transactions, and were going in face of the Ministry's regulations. Such a position could not be tolerated in view of the importance of the work and the tungsten alloy.

For the defence, it was argued that the summonses were misconceived, for we had not yet set up in this country an all-powerful autocracy which had rights outside the plain words of the regulations, not only to control and order manufacture, but to close down works if they chose.

The Bench decided to convict the firm on five charges of unlawful sales, and inflicted a fine of £20 in each, and also a fine of £5 for the false return in the month of September. An order was made for the firm to pay £10 10s. towards the costs of the prosecution. The cases against Mr. Heslop were dismissed.

High-Speed Steel Patent.

The Stahlwerk Becker patent for high-speed steel was before Mr. Justice Younger, in the Chancery Division recently, on a summons by Darwin & Milner, Limited, for further and better particulars of Arthur Balfour & Company's objection to the registration. Arthur Balfour & Company petitioned to revoke the patent on the ground, amongst others of prior publication, alleging that a similar process had been used in Sheffield works prior to the date of registration. The patent was for the manufacture of high-speed tool steel by the addition of cobalt to the known process, preferably 15 per cent.

Arthur Balfour & Company commenced proceedings to revoke the patent, which were originally opposed by Stahlwerk Becker & Company, who were alien enemies, but they now took no part. The opposition to the revocation petition was, however, continued by Darwin & Milner, Limited, who claimed to be the licensees in this country, but their rights were denied, and a summons was pending to strike them out.

Mr. Kerly, in support of the summons, said it was alleged that high-speed tool steel was made in Sheffield with the addition of cobalt prior to the date of the patent, and they wanted the particulars of that manufacture. It was essential for them to know, if cobalt was used, what proportion it bore to the other ingredients.

Mr. Colefax, K.C., who appeared for Arthur Balfour & Company, submitted that there was a special rule with regard to these matters which the summons did not comply with, and further percentages did not form any part of the invention. It was especially essential that this process should be used in this country at the present time, and if the petitioners were right in their contention Darwin & Milner, Limited, had no interest in the matter whatever.

In giving judgment, his lordship said that besides more accurate percentages of the steel alleged to have been manufactured at Sheffield, the respondents asked for the name under which such steel was sold. He did not think that the petitioners could be required to give those particulars. He thought, however, that the quantities of carbon used in each batch should be given, though as the patentee himself had not been definite as to the quantity of cobalt to be used, he did not think further particulars could be required under that head. He directed the petitioners to make a further affidavit of documents, but directed the order not to be acted upon until the summons with reference to the respondents' *locus standi* had been disposed of.

Holidays at Munition Works.

An interesting point relating to the right of munition workers to claim compensation for enforced holidays was decided before the Manchester Munitions Tribunal on June 20. A foundry firm was directed to pay over a proportion of wages to five of their workmen for idle days in Whit-week. In deciding the case in favour of the men, the Chairman said that with compensation the applicants must also have their leaving certificates. That was a technical point in the Act, but he hoped the men would not take advantage of it and use the certificates that would be granted them. He directed that four of the men should be paid £2 4s. each, and the fifth 30s., as representing the average amount of wages they would have earned on the days in Whit-week which were not worked, and which were not regarded as included in the usual holiday time.

Wood Working Machinery.

The Ministry of Munitions has issued an Order that the war material to which Regulation 30 A of the Defence of the Realm Regulations applies shall include all machinery driven by power and suitable for use in cutting, working, or operating on wood, including sawing machines of all descriptions, general joiners, mortise, tenon, and boring machines, lathes and rounding machines, box and cask making machines, and all machines necessary thereto, scraping and sand-papering machines, wheelwright machinery, firewood making and bundling machinery, wood woolfibre and pulp machinery, saw sharpening and setting machines, saw stretchers and brazing apparatus, and all machines for grinding, planing, or moulding irons. Applications for a permit to purchase or enter into negotiations for the purchase of the war material referred to in the above Order should be made to the Executive Officers of the Area Clearing House Boards, whose addresses may be obtained upon application to the Director, Central Clearing House, Ministry of Munitions, Charing Cross Buildings, S.W.2. All applications for a permit to sell or enter into negotiations for the sale of the war material referred to in the above Order should be made to the Director of Wood Working Machinery, Charing Cross Buildings, S.W.2.

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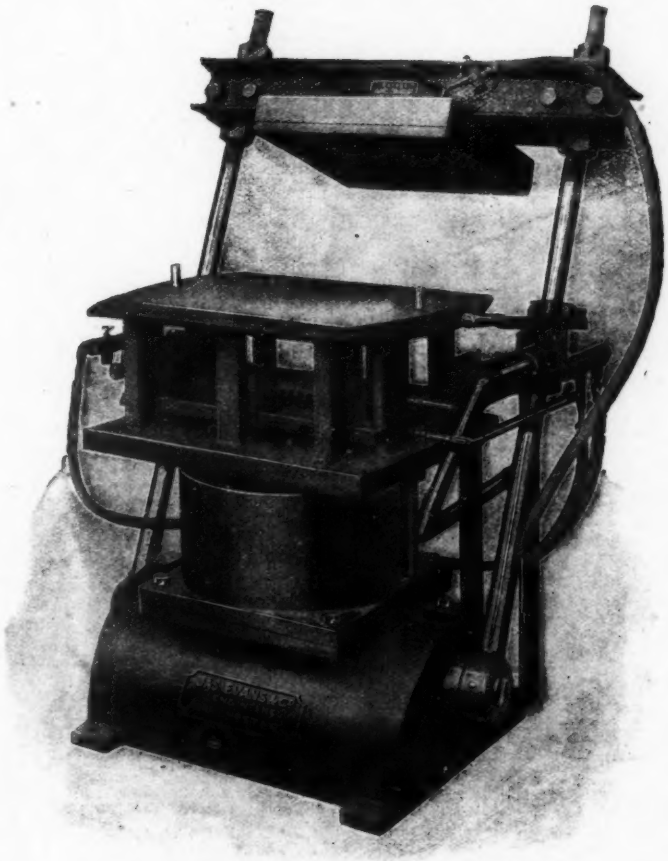

JAMES EVANS & CO., BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

Personal.

THE late Mr. P. Lodwidge, retired iron merchant, Sunderland, left estate valued at £6,380 gross.

THE late Mr. William Adams, coach ironworks maker, of Birmingham, left estate valued at £59,572 gross.

THE late Mr. James Gilchrist, chairman of Barclay, Curle & Company, Limited, left personal estate in the United Kingdom valued at £148,480.

THE gross value of the estate of the late Mr. C. Winn, head of the firm of C. Winn & Company, engineers, is £35,002, including £32,433 net personalty.

SECOND-LIEUT. R. W. WILLIAMS, of the Royal Engineers, who has been awarded the Military Cross, was, prior to the war, an engineer at the Cargo Fleet Works.

THE gross value of the estate of the late Mr. G. A. Hobson, partner in the firm of Sir Douglas Fox and Partners, Limited, is £58,825, including net personalty, £56,497.

MR. H. M. GRAYSON, a director of H. & C. Grayson, Limited, and of R. & H. Green, and Silly Weir, Limited, has been appointed Director of Ship Repairing to the Admiralty.

THE late Mr. H. E. H. Haynes, managing director of J. P. Haynes, Limited, iron and steel merchants, left estate of the value of £46,247 gross, including net personalty £38,437.

CAPTAIN (Temporary Major) WILLIAM REID BROWN, R.G.A., who has been awarded the D.S.O., was, prior to the outbreak of war, assistant manager at the Dowlais Ironworks, Cardiff.

MR. JOSEPH WILKINSON has been appointed manager of the Harrington Ironworks, near Workington (Cumberland), belonging to the Workington Iron and Steel Company, Limited.

THE late Mr. Herbert Hanbury Smith-Carington, a director of Sir W. G. Armstrong, Whitworth, & Company, Limited, has left estate valued at £238,613 gross, the net personalty being £95,840.

SEC. LIEUT J. G. KIRKUP, son of Mr. G. J. Kirkup, of Newcastle, has been awarded the Military Cross. Previous to the outbreak of war he was with the Consett Iron Company, Limited.

THE late Mr. Albert de Lande Long, J.P., of Crosby Cote, Northallerton, one of the founders of the firm of Dorman, Long & Company, Limited, left estate valued at £94,693 11s. 6d., with net personalty £93,789 19s. 1d.

MR. G. S. F. EDWARDS, resident director of the shipbuilding and ship-repairing establishment of Smith's Dock Company, Limited, at Middlesbrough, has temporarily relinquished his duties to become Director of Ship Repairs at the Admiralty.

CAPTAIN THE HON. ROLAND D. KITSON, West Yorkshire Regiment, a son of the late Lord Airedale, and a director of the Monkbridge Iron & Steel Company, and of Bolckow, Vaughan & Company, Limited, has been awarded the Military Cross.

MR. J. W. CAWSTON, Assistant Comptroller and Auditor, has been appointed Deputy-Master and Comptroller of the Royal Mint in succession to Sir Thomas Henry Elliott, retired. Sir Sydney Olivier succeeds to the position of Assistant Comptroller and Auditor.

LIEUT.-COLONEL H. LUHRS, who has had conferred upon him the Order of C.M.G., was, prior to the war, one of the managers of the North-Eastern Marine Engineering Company, Limited, Wallsend, but now holds a position at the Ministry of Munitions, after a long period of active service in France.

As previously announced, Mr. T. Bell, managing director of John Brown & Company, Limited, at Clydebank, has accepted a position as Assistant Admiralty Controller. We are informed that the management of the works and yards at Clydebank will continue to be carried on as hitherto by Mr. W. J. Luke, the shipbuilding director of the firm, and Engineer Commander W. H. Wood, engineering director, and the local board of directors.

THE Secretary of the Admiralty makes the following announcement regarding the constitution of the Admiralty Department, which is being established under Vice-Admiral Sir Eric Geddes as Controller. Sir Eustace H. Tennyson d'Eyncourt continues to hold the office of Director of Naval Construction. The following appointments to the Controller's Department have been made:—Deputy Controllers:—Mr. T. Bell, late managing director of Messrs. John Brown & Companys' Clydebank Establishment, to be Deputy Controller for Dockyards and Shipbuilding; Major-General A. S. Collard, Director of Inland Waterways and Docks in the Department of the Director-General of Movements and Railways, to be Deputy Controller for Auxiliary Shipbuilding; Sir Vincent L. Raven, Chief Superintendent of Ordnance Factories, to be Deputy Controller for Armament Production. Directors:—Mr. W. J. Berry, Assistant Director of Naval Construction, to be Director of Warship Production; Rear-Admiral Laurence E. Power, Superintendent of Contract-Built Ships, to be Director of Dockyards and Repairs; Colonel H. Livesey, Deputy Director of Inland Waterways and Docks, to be Director of Contracts during the absence of Sir Frederick W. Black, who is now serving as Director-General of Munitions Supply in the Ministry of Munitions; Lieutenant-Colonel J. G. Beharrel, Assistant Director-General of Movements and Railways, to be Director of Statistics; Lieutenant-Colonel R. S. Horne to be a Director charged with all questions relating to the supply, distribution, and allotment of raw materials. Sir James B. Marshall, Director of Dockyards and Dockyard Work, and Mr. W. H. Whiting, Superintendent of Construction Accounts and Contract Work, are now relinquishing the appointments which they continued to hold at the request of the Board of Admiralty since they reached the normal age of retirement from the Public Service.

Applications for Patents.

Alldays & Onions Pneumatic Engineering Company, and Allday, W. Apparatus or furnaces for gasifying or vaporising liquid fuel. 7,084. May 17.

Allen, B. J., and Ames, R. Y. Vacuum-jacketed moulds for casting articles from slip mixtures. 6,973. May 15.

Archer, A. E., and Blakey's Boot Protectors, Limited. Formation and pricking of sand moulds or cakes for production of metal castings, etc. 7,482. May 24.

Atkinson, J. S. Machinery for stripping ingots. 8,087. June 6.

Bather, H. K. Annealing, etc., furnaces. 7,622. May 26.

Beevers, L. Testing-device for measuring pressures. 7,353. May 22.

Bingham, H. C. Means for removal of dust from furnace gases. 7,390. May 22.

Broughall, E. H., Herbert, A., & Wilding, B. Permanent moulds for iron castings. 7,308. May 21.

Brown, G., and Reid Bros. Measuring-machines for testing hardness of metals. 7,380. May 22.

Cockram, T. R. J. Apparatus for casting ingot moulds. 8,283. June 9.

Coley, H. E., and Wilbraham, E. C. B. Refractory bricks, cruicibles, etc., from zirconium. 7,346. May 22.

Coley, E. E., and Wilbraham, E. C. B. Refractory bricks, etc., and process of manufacture thereof. 7,347. May 22.

Coley, H. E., and Wilbraham, E. C. B. Carbonaceous compound for use as an abrasive, etc. 7,348. May 22.

Colonnetti, G., and Pozzo, A. Testing iron. 8,225. June 8. (Italy, June 16, 1916.)

Colonnetti, G., and Pozzo, A. Apparatus for testing iron. 8,233. June 8. (Italy, July 7, 1915.)

Colonnetti, G., and Pozzo, A. Testing iron. 8,234. June 8.

Cooper Company. Alloy. 6,846. May 14. (United States, October 30, 1916.)

Cooper, P., and Taylor, Tunnicliff & Company. Presses for moulding plastic substances. 7,063. May 17.

Etchells, H., and Greaves, H. A. Electric-furnace regulators. 8,176. June 8.

Ley's Malleable Castings Company. Time-checking apparatus. 7,289. May 21.

Moffat, J. R. Chilled moulds. 7,473. May 24.

Richmond Gas Stove & Meter Company. Steel furnaces. 6,821. May 14

Stein & Atkinson. Machinery for stripping ingots. 8,087. June 6.

Thompson, J. Steel furnaces. 6,821. May 14.

Williams, W. H. Casting metals. 8,077. June 6.

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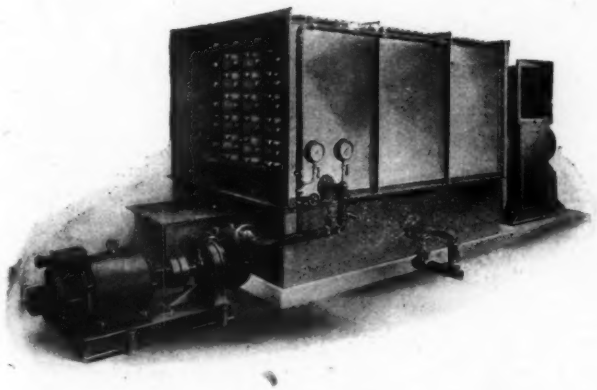

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New Companies.

British Barimar-Thermit Welding Company, Limited.—Capital £5,000 in £1 shares.

Robert Walker & Son (Manchester), Limited.—Capital £5,000 in £1 shares, to carry on the business of mechanical engineers.

Tullite, Limited.—Capital £5,400 in 2s. shares, to carry on the business of general engineers. Registered office: 39, Victoria Street, S.W.

A. J. Croft & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of brass casters, Holly Lane, Perry Bar, near Birmingham.

Wilkinson & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of merchants, factors, and manufacturers of anvils, vices, etc.

A. & R. Mason, Limited.—Capital £10,000 in £1 shares (6,000 pref.), to carry on the business of iron-founders. Registered offices:—2, Evelyn Street, Deptford, S.E.

Precision Gauges, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers of gauges, etc. Registered office: 4, Wrentham Street, Birmingham.

Glass Engineering (Edinburgh) Company, Limited.—Capital £1,000 in £1 shares, to acquire the business of the Glass Engineering Company. Registered office:—Norton Park, Edinburgh.

George N. Potter, Limited.—Capital £5,000 in £1 shares, to purchase the business of brass-founders, metal workers, etc. The first directors are G. C. Potter, H. A. Potter, and F. N. Potter.

Alder & Mackay, Limited. — Capital £150,000 in 120,000 preference and 30,000 ordinary shares of £1 each, to acquire the business of gas meter manufacturers and brassfounders at New Grange Works, Edinburgh.

Russell Brothers (Walsall), Limited.—Capital £20,000 in £1 shares, to take over the business of a tube maker carried on by J. B. Russell, as Russell Brothers, at the Bradford Tube Works, Upper Brook Street, Walsall, and elsewhere.

Thomas Warren & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers, exporters and importers of and dealers in hydraulic and other fitting presses and machinery. The first directors are W. Thomas and R. C. Warren.

Renishaw Iron Company, Limited.—Capital £50,000 in £1 shares. The directors are G. A. Eastwood, F. Chambers, W. A. Musgrove, H. D. R. Bayley, T. Greensmith, T. G. Mellors, and J. H. W. Laverick. Registered offices: Renishaw, near Chesterfield.

Marshall & Company (Penarth), Limited. — Capital £1,000 in £1 shares, to carry on the business of general mill furnishers, etc. The first directors are Wm. Marshall (permanent governing director), Mrs. M. A. Marshall, and J. Marshall. Registered office: 7, Church Road, Penarth.

John Barnsley & Sons, Limited.—Capital £20,000 in £1 shares (9,000 6 per cent. cumulative preference), to take over the business of John Barnsley & Sons, manufacturers of hydraulic, pneumatic, electrical, steam and general engineering products &c. Registered office:—Cradley Road.

Amble Engineering Company, Limited.—Capital £1,000 in £1 shares, to take over the business carried on by G. Linton, J. Carse, G. Brown, A. Johnson and T. Parker at Amble, Northumberland, as the Amble Engineering Company. The first directors are G. Linton, J. Carse and G. Brown.

Wood, Walsh & Company, Limited.—Capital £4,000 in 3,990 £1 ordinary shares, and 200 1s. deferred shares, to take over the business of engineers carried on by J. & F. Wood and F. H. Walsh, as Wood, Walsh & Company, at Sheffield. The first directors are C. E Richardson and J. Wood.

Steam-Driven Lorries and Trailers.

The Minister of Munitions has issued an Order requiring every individual or company (other than railway companies) owning or having in their possession or under their control any steam-driven highway lorries or trailers in Great Britain to send in to the Deputy Director-General of Railway Material Licences, Ministry of Munitions, Whitehall Place, London, S.W.1, within 14 days, returns containing the particulars with regard to such steam lorries and trailers in the form set out below, and any further particulars required by the Deputy Director-General of Railway Material Licences.

The following are the particulars required:—(a) Registered letters and numbers. (b) Owner's name and full address. (c) Maker of the lorry. (d) Date on which they were built. (e) Working pressure of boiler lb. sq. in. (f) Whether steam boiler is fired with coal, coke, or oil fuel. (g) Name of insurance company for the boiler. (h) Net carrying capacity of lorry in tons Net carrying capacity of trailer in tons. (i) Weight of lorry unloaded. Weight of trailer unloaded. (j) Is the lorry a normal or of a special type? (k) General condition of the lorry and mechanism. (l) Work (if any) on which the lorry and (or) trailer is usually employed. No separate official form is being issued for the purposes of the return.

Profits on Sub-Contracts.

A new Defence of the Realm regulation empowers the Admiralty, the Army Council, and the Ministry of Munitions to vary the terms of any sub-contract for Government work where it appears to them that the rate of profit is unreasonable or excessive by the substitution of such terms as they may think fair and reasonable. In such event the price payable to the principal contractor under the principal contract will be reduced.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.

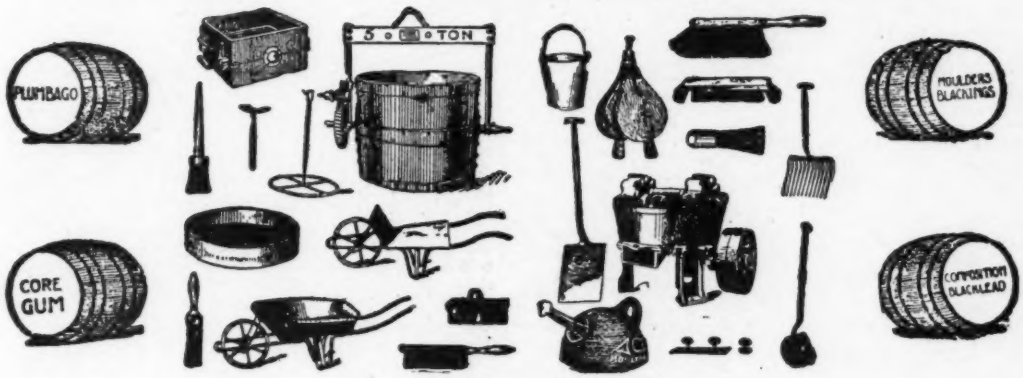
KINDLY HAND US YOUR ENQUIRIES.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



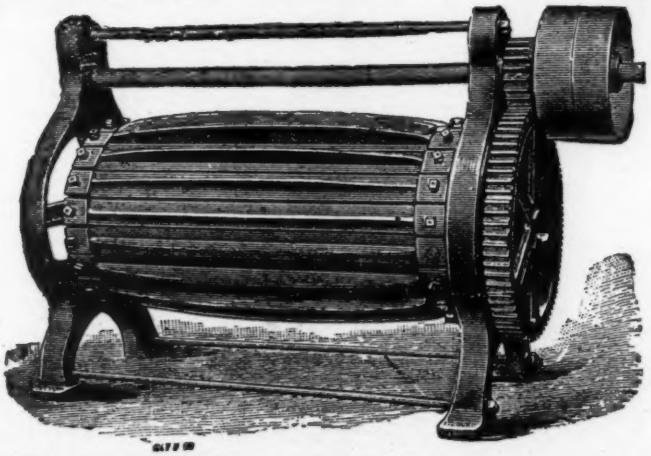
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

These maximum prices of iron, steel and coke were fixed by the Government until June 30, 1916, and thereafter until further notice. Makers may sell for delivery after June 30, on the understanding that the fixed maximum prices ruling on the 1st day of any month during the period of the contract will apply to all deliveries made during that month. This intimation must not be taken to authorise any sale or purchase or other dealing prohibited under the Defence of the Realm Regulations

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos., 1, 2 and 3	6	7	6
Special under 0.03 P. & S... ..	6	15	6
„ „ 0.02 „	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S. ..	6	7	6
Special under 0.03 P & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3..	6	2	6
Special under 0.03 P. & S. ..	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Lincolnshire, basic or foundry ..	4	12	6
Cleveland, No. 1	4	11	6
„ other grades	4	7	6
Northamptonshire, forge	4	7	6
„ fdy numbers	89/0		94/0
Derbyshire, forge	4	10	0
„ foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge ..	4	10	0
„ „ foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
„ „ foundry	4	17	6
„ „ basic	4	17	6
South Staffordshire—			
Part mine forge	4	15	0
„ foundry	4	17	6
Common Staffordshire ..	4	10	0
All mine forge	5	15	0
„ foundry	6	0	0
Warm air forge	7	5	0
„ foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings	5d	
Bar Ends	6d	

Both per lb. net delivered steel makers works

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton			
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	—		
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	—		
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	—		
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	—		
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	—		
Ferro-titanium: 23/25%, per lb. carbonless..	—		
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained ..	—		
Ferro-phosphorus: 20/25%. Per ton	—		
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	—		
*Ferro-manganese 80%	—		
„ export	—		

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s.	d.	£	s.	d.
Standard, Cash	130	0	0	130	10	0
Three months	129	10	0	130	0	0
Electrolytic ..	142	0	0	138	0	0
Tough ..	140	0	0	136	0	0
Best selected ..	140	0	0	136	0	0

Tin.

Standard, Cash	243	5	0	243	10	0
„ Three months	237	0	0	237	10	0
English Ingots ..	—			247	0	0
Bars	—			248	0	0
Refined	—			—		

Spelter.

American	54	0	0	50	0	0
Specials.. ..	—			—		
Hard	—			—		
British	—			—		

Lead.

Soft Foreign	30	10	0	29	10	0
English	—			Nom		

Antimony.

Regulus	—			85	0	0

Aluminium.

Virgin Metal 98/99% per ton	—	—

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots.. ..	—
CASTINGS.	**Per lb.**
I. or II.	—
III. IV. or V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid ..	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. 35/- above price of best selected copper.

15 per cent. Phosphor Copper .. 40/- above price B.S.

Phosphor Tin (5 per cent.) .. £23 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FARNLEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**

98/99% purity, per lb.	—	—

***Nickel.**

In cubes, 98/99% purity Per ton	—	

Nickel Silver.

	per lb.
Ingots for raising	—
Ingots for Spoons and Forks ..	—
„ rolled to spoon size ..	—

***Tungsten Metal Powder.**

96/98% purity.. per lb. ..	—

***Molybdenum Metal.**

96/98% purity.. per lb. ..	—

***Cobalt Metal.**

97% purity .. per lb. ..	—

Quicksilver.

75 lb. bottle	—

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting..	105	0	—	
Iron scrap cast (cupola metal)	90	0	95	0

London (f.o.b.).

Heavy steel			100	0
Light „			55	0
Heavy cast			95	0

Control Prices.

Heavy Steel Melting Scrap	105	0	125	0
Turnings and Borings			50	0
Wrought Iron Scrap ..	105	0	125	0

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap ..	—		
Hy. Selected Scrap Brass ..	—		
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap ..	—		
Re-melted Ingot Lead	—		

Stocks.

Metals.	Tons.
Copper, Europe and afloat	—
Tin London, Holland, U.S.A. and afloat	—

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	31	0	—	

Glasgow.

Foundry Coke	—		42	0
Furnace Coke	30	0	—	
Gas Coke	—			

London.

Welsh or Durham Foundry, d/d London Stations in truck	45	6	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6	—	

CONTROL PRICES OF COKE.

	s	d.
Durham and Northumberland blast furnace	28	0
„ foundry	30	6
South Yorkshire, West Yorkshire, Lancashire, Staffordshire and Midland Counties blast furnace	25	8
South Wales blast furnace ..	30	0
„ foundry	43	0

All per ton net. f.o.t. ovens.

SITUATIONS VACANT AND WANTED.

PATTERNMAKER FOREMAN, accustomed to light, accurate work in wood, stucco and metal, wanted immediately for firm doing important Government work. No person already engaged on Government work will be engaged. — Apply to nearest Employment Exchange, mentioning this paper and No. 4887.

MOULDERS (General) and COREMAKER required immediately for Government factory. Experienced men used to high-class petrol motor work; good wages and prospects, war bonus and overtime. No man on Government work can be engaged.—Apply your nearest Employment Exchange, mentioning this paper and No. A3341.

FOREMAN for Foundry, practical man, used to loam and other castings; good disciplinarian; Government work.—MONOMETER MANUFACTURING CO., Whitehouse Street, Aston; or Albion Foundry, Browning Street, Ladywood.

FOUNDRY MANAGER, at liberty soon, desires appointment, wide experience, light castings trade; must be Government work; good organiser, first-class references.—Address Box 884, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOUNDRY SUPERINTENDENT Wanted for large Aluminium Foundry on Government work; must have good practical experience, be good organiser and able to control men. Good salary and commission to right man; permanency.—Give full details as to qualifications, state age, salary required, &c., to Box 882, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

GENERAL MANAGER Wanted for Foundry, near London, doing Government work; must have had practical experience. Excellent opportunity for suitable man; a liberal commission will be paid on results, in addition to salary.—Write, stating full qualifications, age, and salary required, to Box 885, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOR SALE AND WANTED.

MONOMETER GAS FURNACES FOR SALE, 300-lb. capacity, £65; 50-lb. capacity, £25. Suitable aluminium or brass. Both ladling type; latest design; nearly new. — METAL SMELTERS, 12, Norfolk Street, W.C.2.

A FIFTY-CWT. Geared Second-hand LADLE for Foundry, in good condition. Price £10 10s.—Address Box 878, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOR SALE.—24-in. Invincible Sand Mixer, capacity 3 tons per hour, for grinding, mixing and screening foundry sands, at lowest cost per ton.—Apply HALL, 26, Paradise Square, Sheffield.

BELT-DRIVEN Fan, 34 in., by Musgrave, overall of casting 5 ft. 3 in. long by 3 ft. 2 in. by 4 ft. 3 in. high, 26-in. outlet.—C. F. DAVIS, 22, Billiter Street, London, E.C.3.

ONE very strongly-built W.I. Steam Box, about 11 ft. long by about 20 ft. wide by 12 in. deep, fitted with internal steam pipes and three W.I. lids for steaming timber. 40-Ton Steel Metal Ladle, 8 ft. 6 in. dia., 8 ft. deep, firebrick lining, lifting shackles, etc., on portable railway, truck 4-ft. 8½-in. gauge, spare ladle and chains.—RICHARD SIZER, LTD., Cornwall Street, Wilmington, Hull.

FOR SALE AND WANTED.—*cont.*

TWO new 300-lb. Town Gas-Fired CRUCIBLE FURNACES, by J. Wright and Eagle Range, Ltd., Birmingham, for Sale.—Offers to THE METALLURGICAL COMPANY, LTD., Walker Gate, Newcastle-on-Tyne.

FOR SALE.—50-cwt. GEARED LADLE for Sale, in good condition.—Apply WESTERN FOUNDRIES, LTD., Southall, Middlesex.

BLOWING FAN, by Alldays, 12-in. outlet; EXHAUST FAN, cast-iron casing, 10-in. outlet and inlet, F. and L. pulleys; BAKER'S BLOWER, 6-in. outlet; 30-in. New Belt-driven VENTILATING FAN, cheap.—PARKER, Siddals, Derby.

FANS AND BLOWERS.—Enquire from our rebuilt Fan Dept. for your needs before placing order elsewhere.

State clearly the volume and pressure, with brief description of working conditions.

We are always open to purchase approved makes of Propeller and Centrifugal Fans.

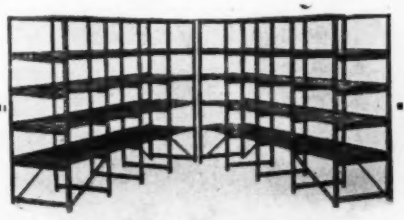
PROGRESSIVE ENGINEERING CO., LTD., LEICESTER.

F. L. HUNT & CO.,

FOUNDRY FURNISHERS AND FOUNDRY REQUISITES

Of every description.

56, 58, 60, CHAPEL STREET, SALFORD, MANCHESTER.



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Fireproof Steel Storage Bins

For Workshop and Warehouse

Write for Details.

Joseph Sankey & Sons, Ltd.,

Hadley Castle Works, WELLINGTON, Shropshire.

PLUMBAGO—CRUCIBLES.

Parting Powder.

WILLIAM OLSEN, LTD.,
Cogan Street, HULL.

FOUNDRY MATERIALS AND REQUISITES.

Largest Stock of Straw and Wood Fibre CORE ROPINGS.

Wax Core Vent.

GLUTRIN—CORE GUM.

FIRE BRICKS & CLAY
CUPOLA BRICKS.
Best Quality.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,
(STOURBRIDGE) Ltd.,
STOURBRIDGE.

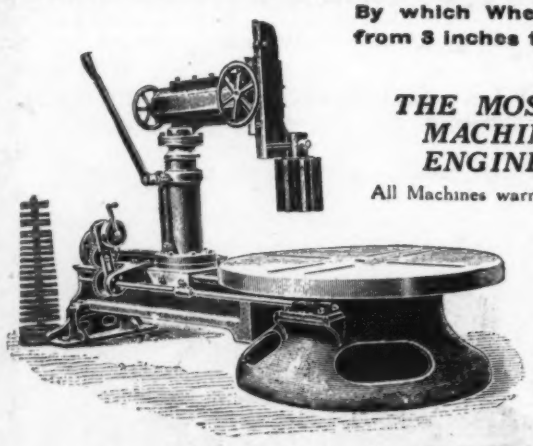
38¼
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL, LTD.
KINNING PARK IRONWORKS, GLASGOW
36"
32¼"

CAN ALSO BE MADE IN ALUMINIUM.

Kindly mention this paper when enquiring or ordering

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, *OLDHAM.*

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394	Hedley Moorwood & Co., Ltd.	21, Church Street, Sheffield	Morod, Sheffield	4318
	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
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C. i.	Macdonald, John, Ltd.	Watt Street, Maryhill, Glasgow.	"Compressor, Glasgow."	61 Maryhill (N)
403	Mansergh, T. E.	Wheathill Charcoal Works, Salford	—	—
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397	Stewart, D. & Co., Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N.)
400	Spermolin Core Co.	Spermolin, Halifax	Halifax	397
C. ii	Thermit Ltd.	675, Commercial Road, E.	Fulmen, Step, London	East 4157
398	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	3456 & 3460 Brdf'd.
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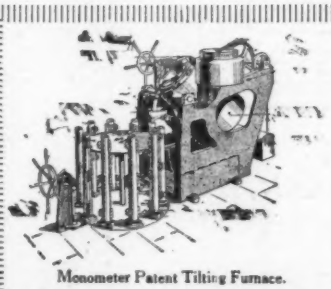
	Watson, T. H. & Co. (of Sheffield), Ltd.	Sheffield	Cargo, Sheffield	1652 (3 lines)
	Whittaker, W. & Sons, Ltd.	Oldham	Whittakers Engineers, Oldham	83
	Wilkinson, Thos. & Co., Ltd.	Middlesbrough	Wilkinson, Middlesbro'	419 Middlesbro.
	Williams, J. (Birmingham Sand), Ltd.	Birmingham	—	—



Monometer Patent Tilting Furnace.

A Paying Proposition!

MELT your own TURNINGS Etc.

IN THE

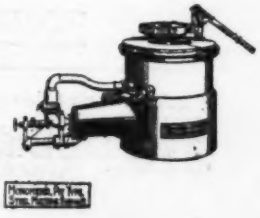
Monometer Tilting and Pit Type Furnaces, and cast by means of the Monometer Turntable.

(Manufactured under License—Hall's Patent).

FOR COPPER, BRASS, GUNMETAL, ALUMINIUM, STEEL, Etc.

The only system producing a non-oxidising incandescent flame.

GAS OR OIL FIRING.



MONOMETER MFG. CO., Ltd., Engineers and Ironfounders, **Aston, BIRMINGHAM.**

Edited by I. H. Hall, Managing Director.

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE is another German speciality superseded and improved.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over again.

FOUNDRITE makes **CORES** unbreakable and the use of **core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.

FOUNDRITE PREVENTS WASTERS.

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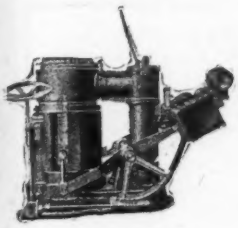

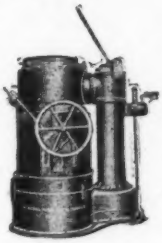

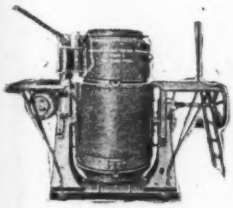

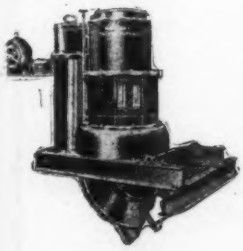

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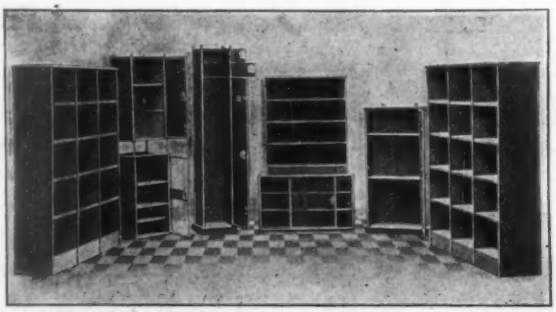

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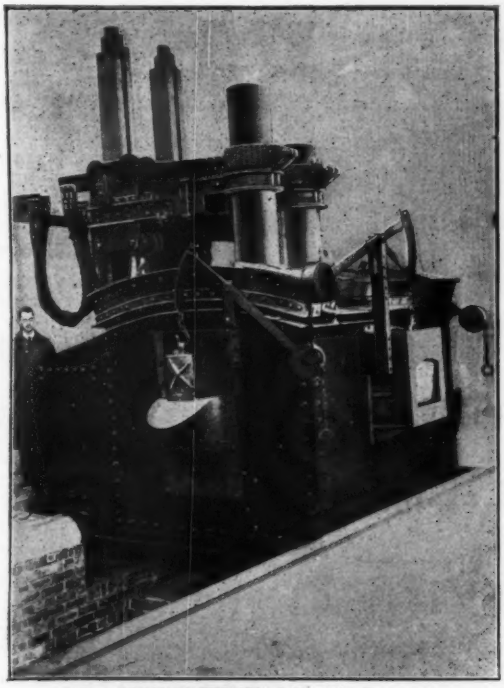

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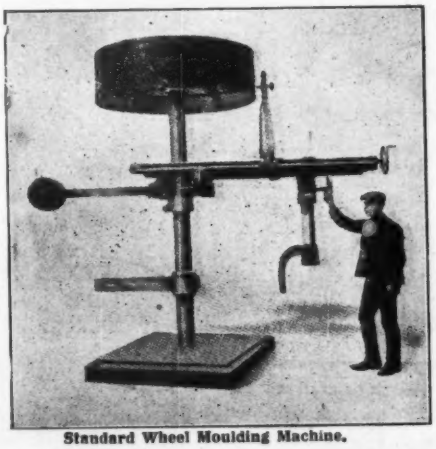

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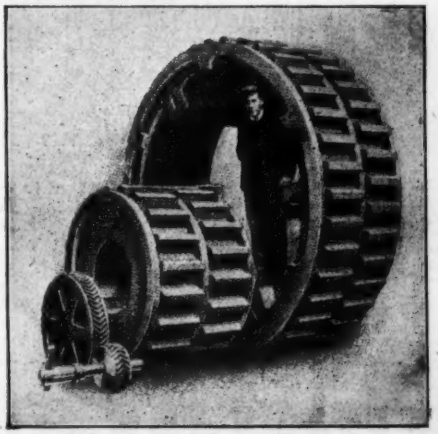

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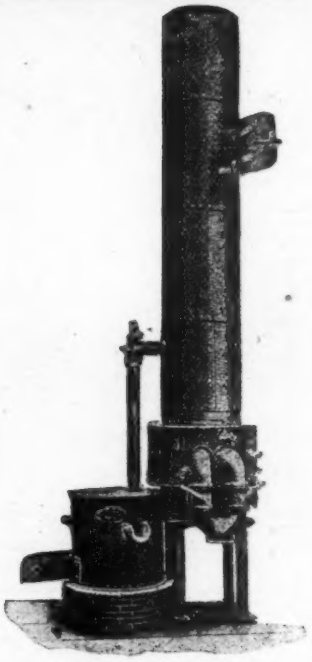

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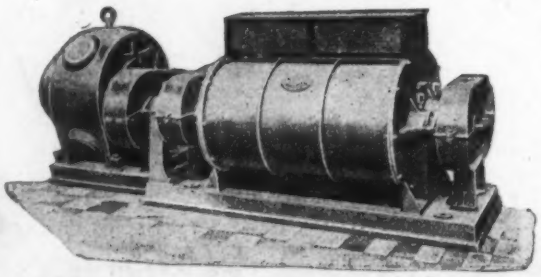

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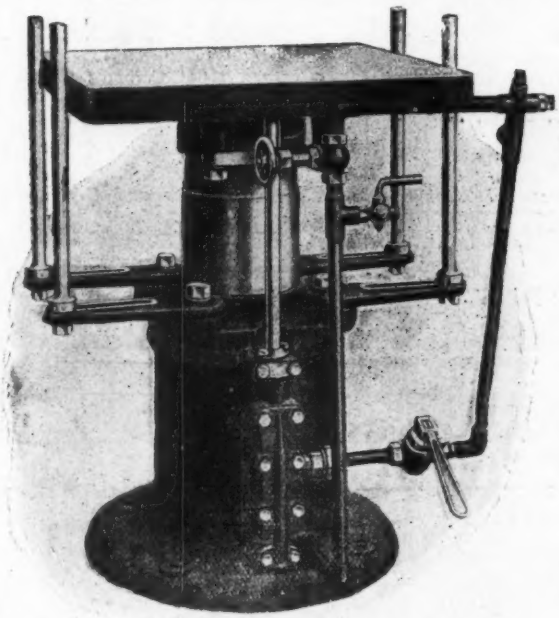

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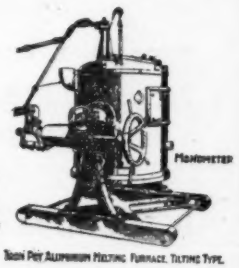

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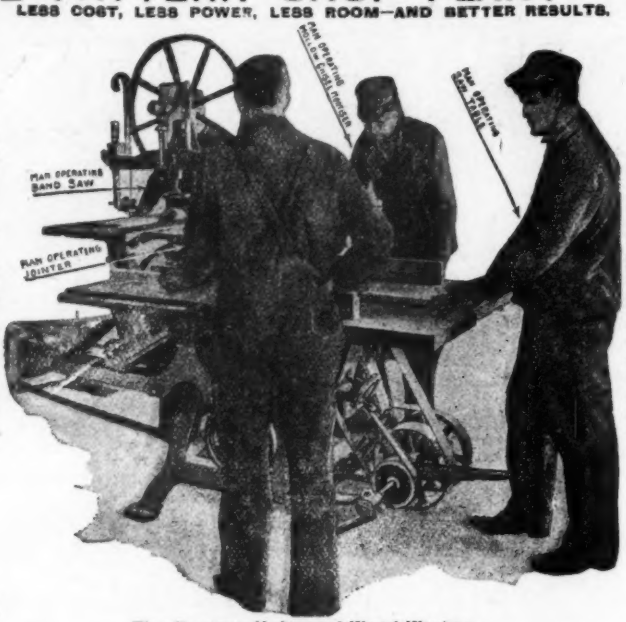

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